Wagga Wagga NSW 29th July 2014

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Agronomy of crops and pastures

Derrick Moot

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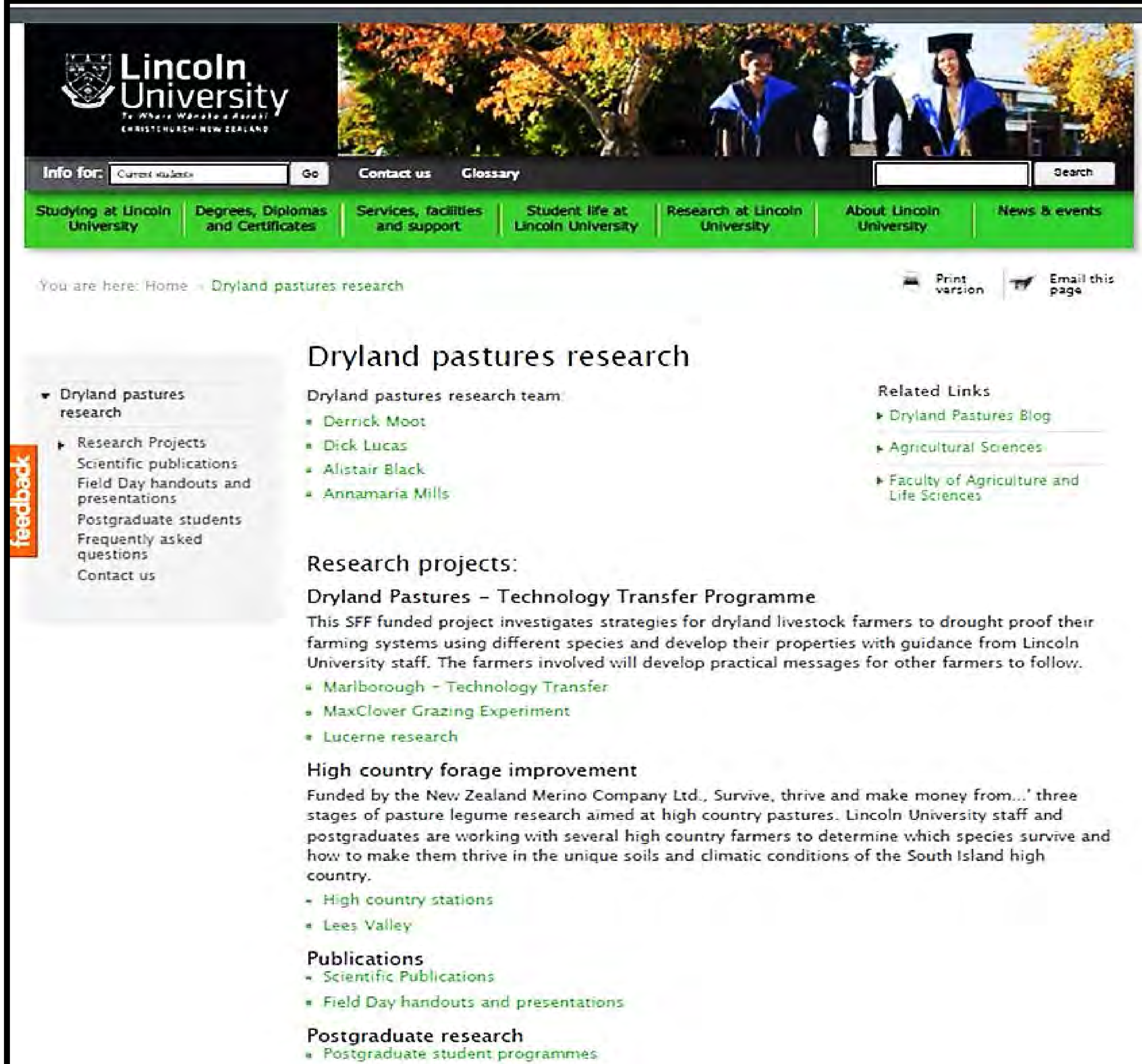
The website…

Info on:

- Current projects
- Field day presentations
- Scientific publications
- FAQs
- Postgraduate study



www.lincoln.ac.nz/dryland


Photo: Dr W.R. Scott

Photo: of Dr W.R. Scott
Outside The Famous Gouse pub in Lincoln

63% Mountain and hill country

13%   Inland basins

Photo: Dr W.R. Scott

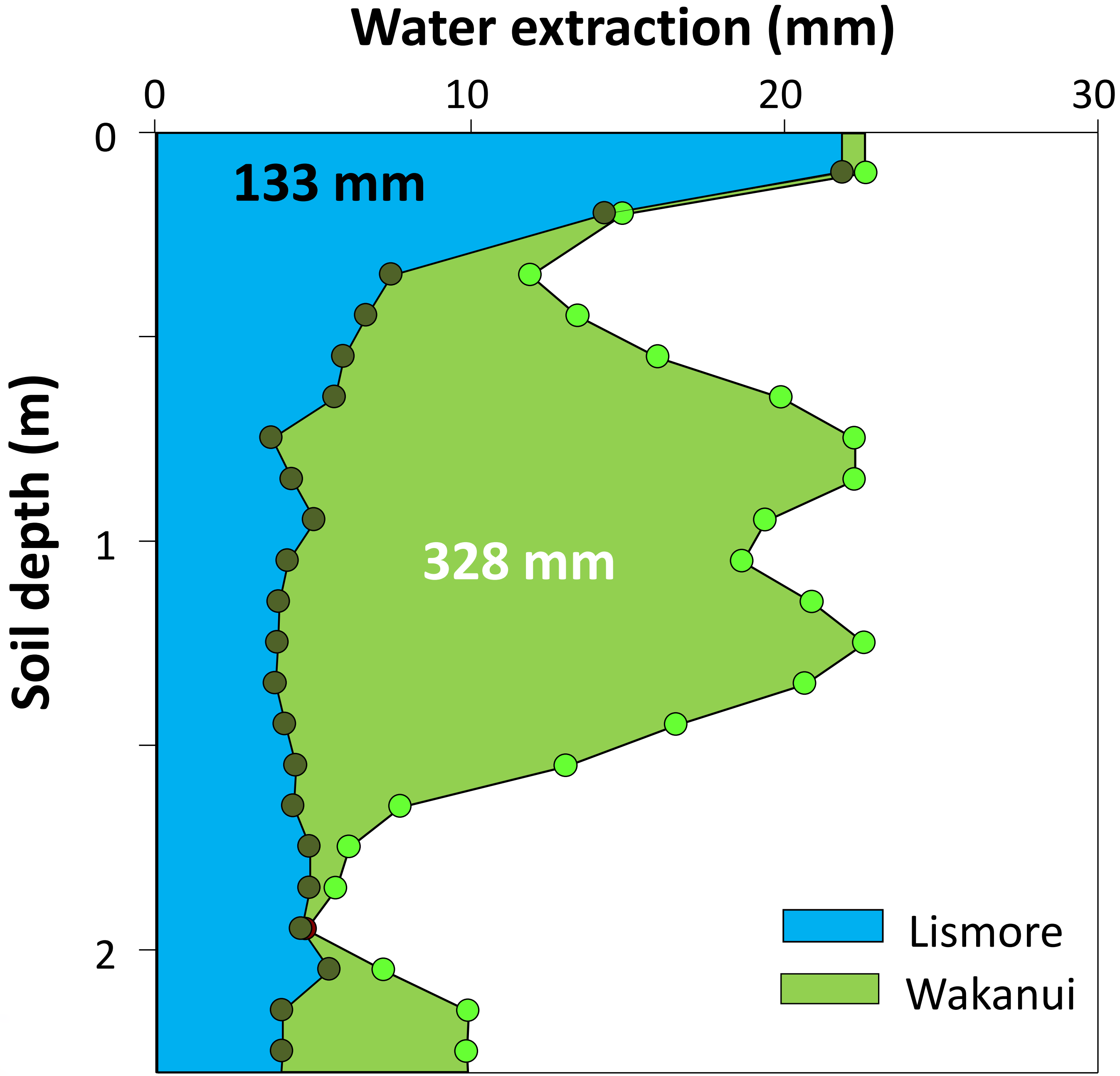
Source: Brown & Naish, GNS


High variability over short spaces

The sediment load of Canterbury rivers is 10x the global average

Photo: Lincoln University Soils Department

Soil water extraction - Wakanui



Soil water extraction

Deep Wakanui soil has 200 mm more available water

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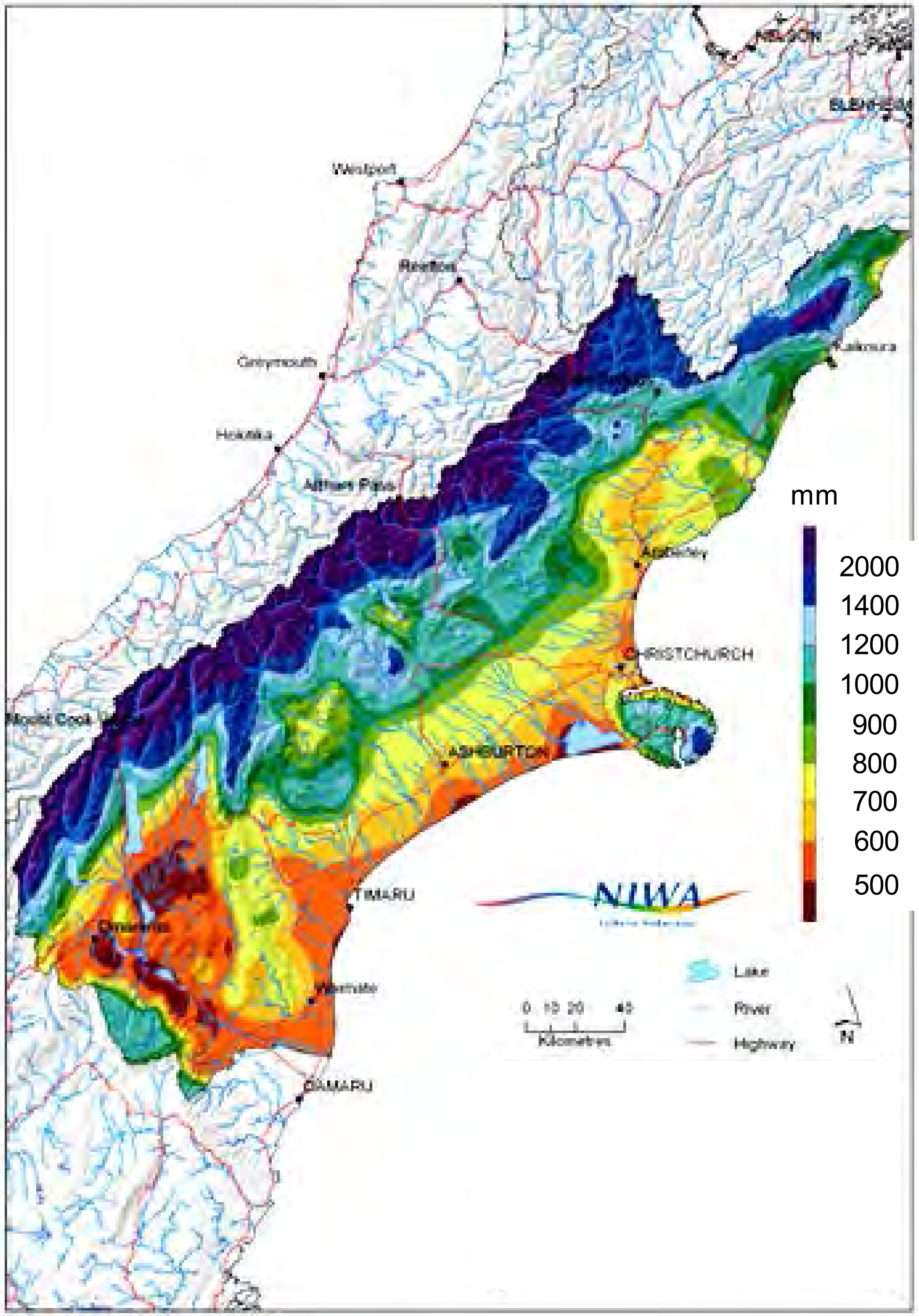
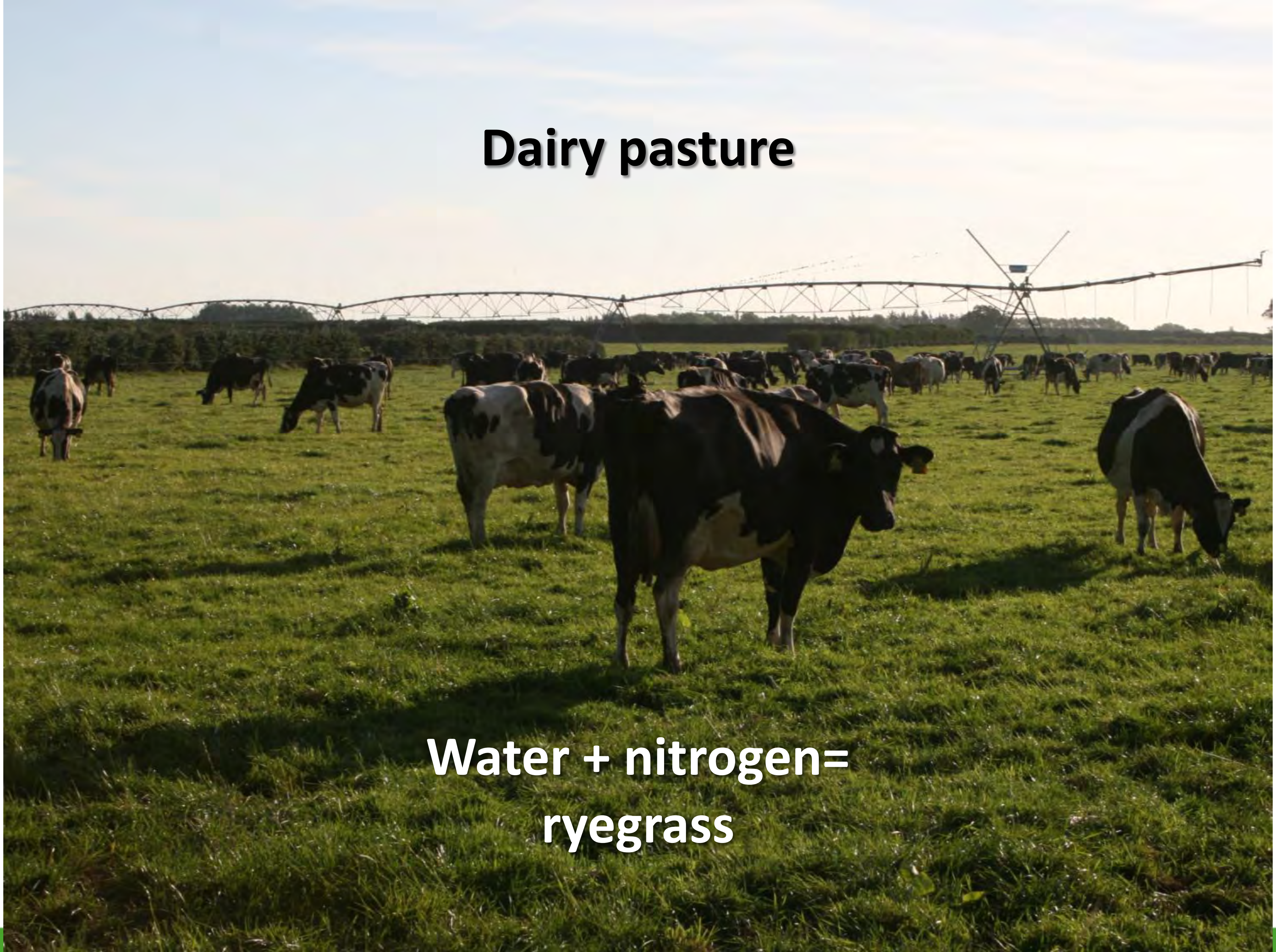
Climate

Median rainfall (mm) (1971-2000)



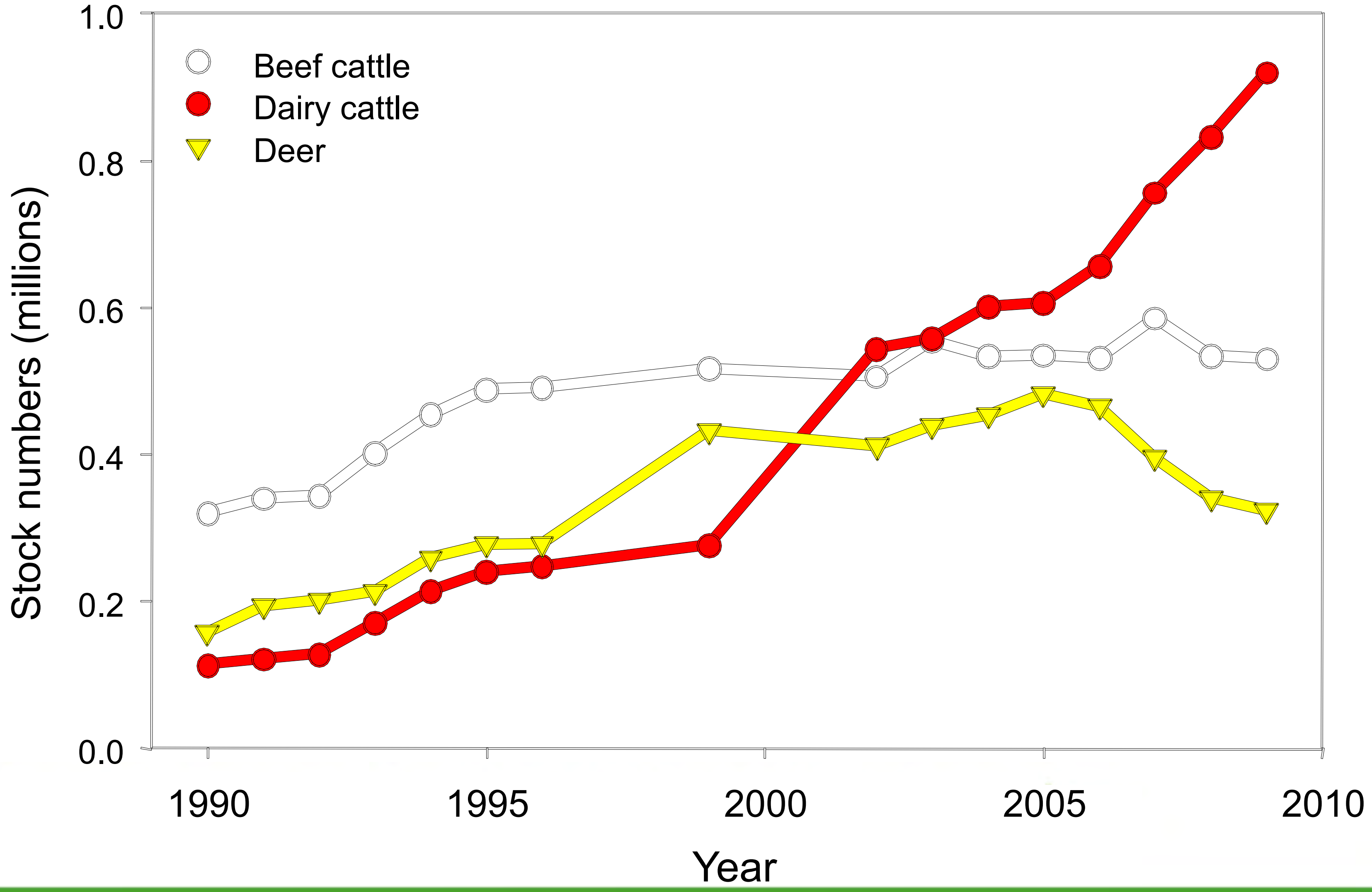
Source: Climate Explorer NIWA, 2010

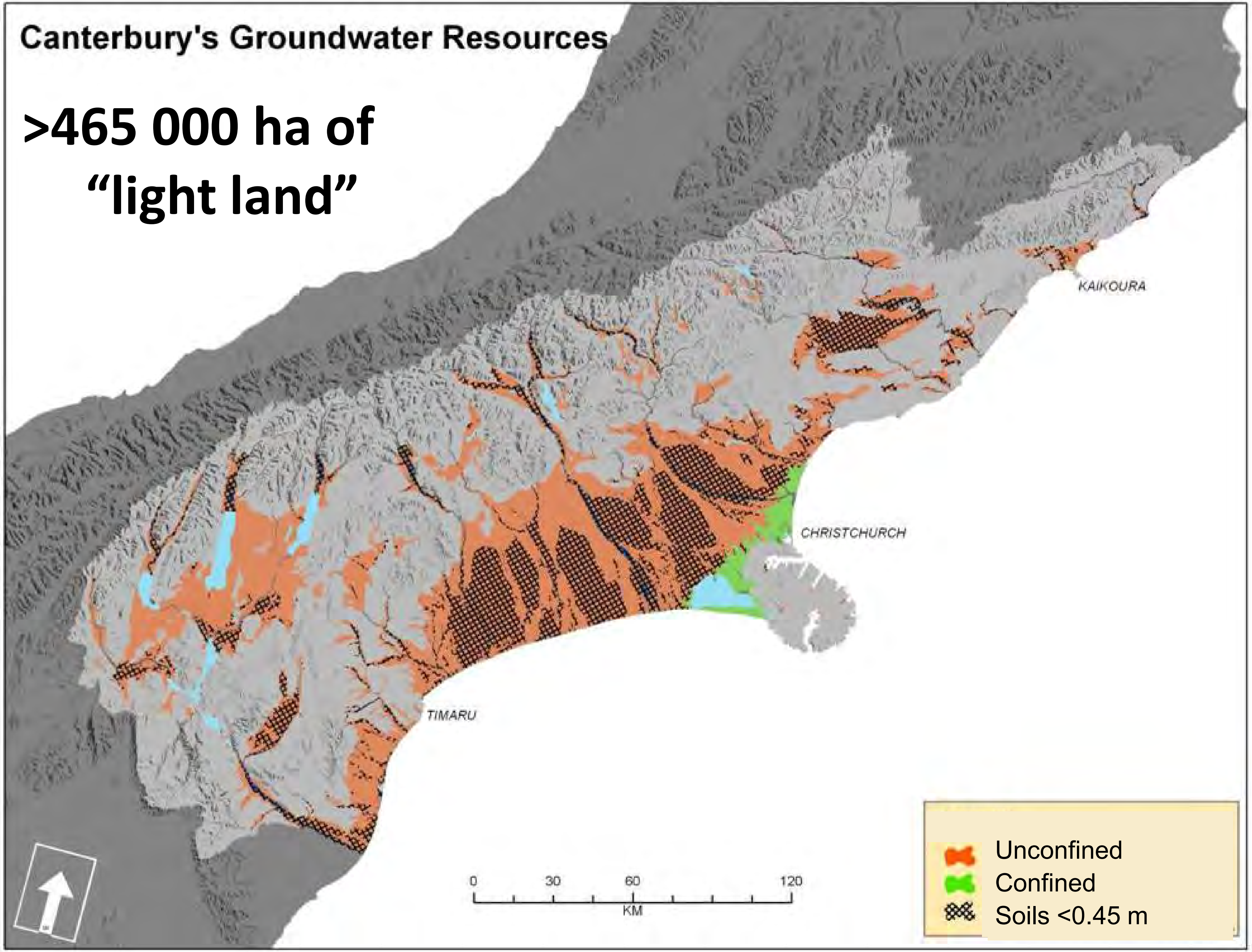
Unimproved scrub land on light soils



Martin *et al*. 2006 NZGA

The population...deer & cattle





Source: Ken Taylor ECan

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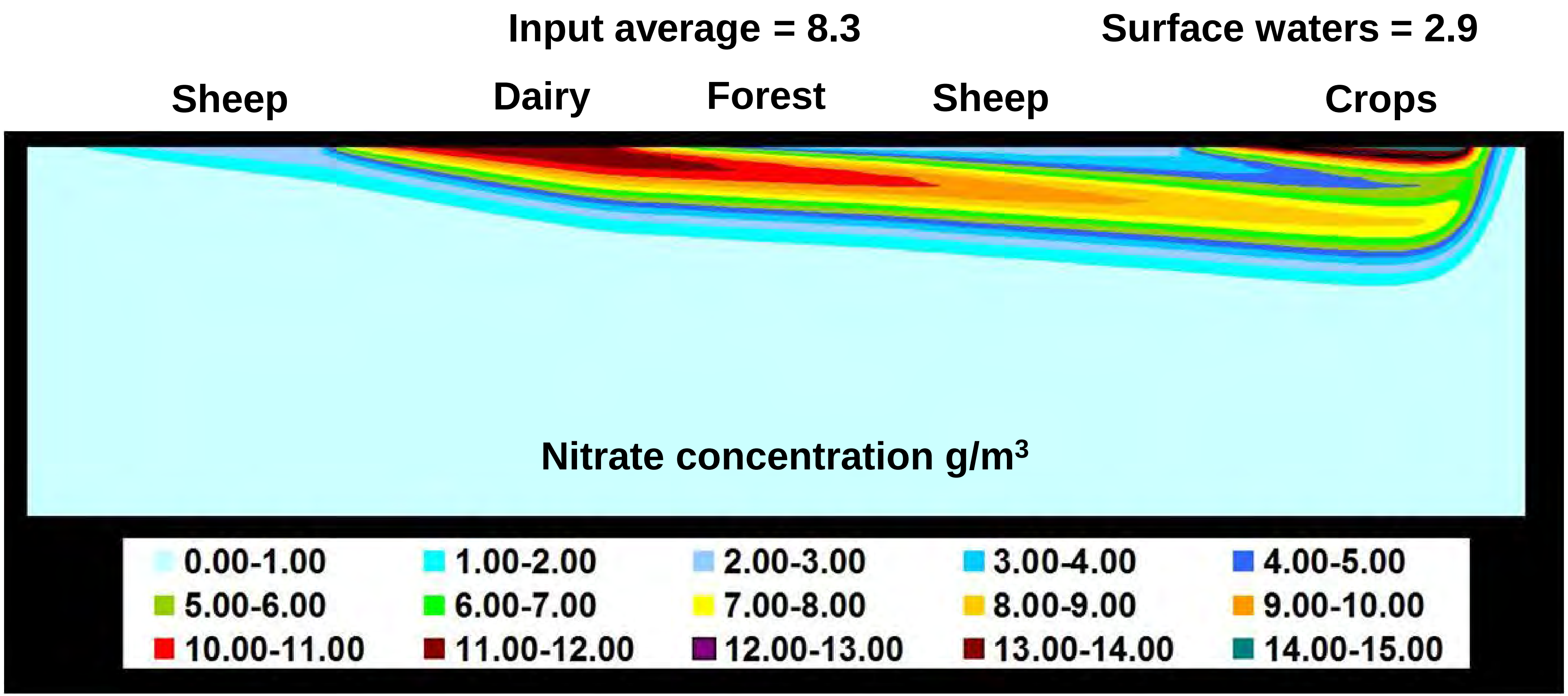
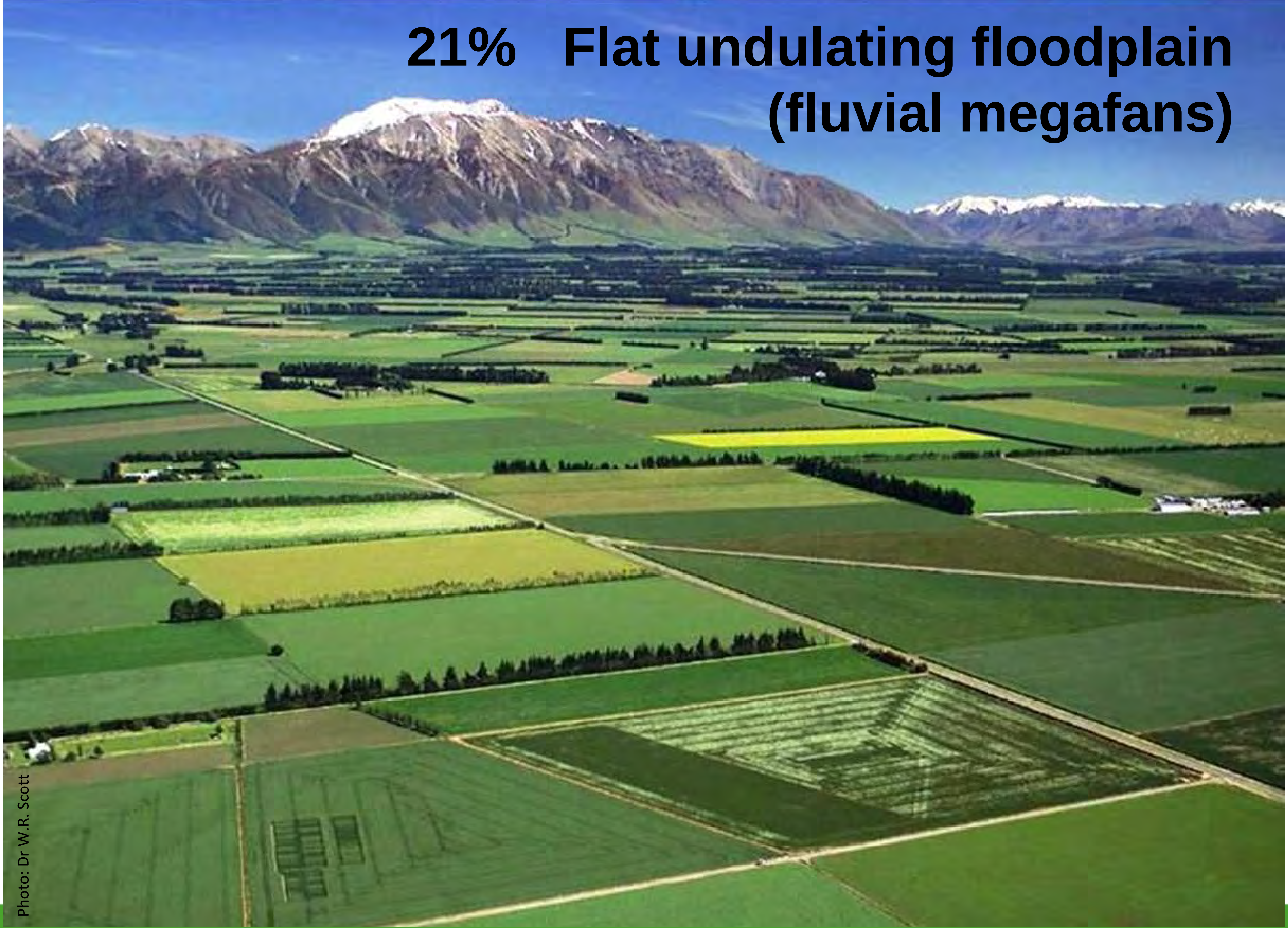
New

Introduction of dairy farming changes the amount & distribution of nitrate in the aquifer.



New Zealand's specialist land-based university

Bidwell *et al*. 2009


21% Flat undulating floodplain
(fluvial megafans)
Photo: Dr W.R. Scott

~60% of the fresh and process peas

Photo: Dr W.R. Scott

Onions for export, 4000 ha of potatoes

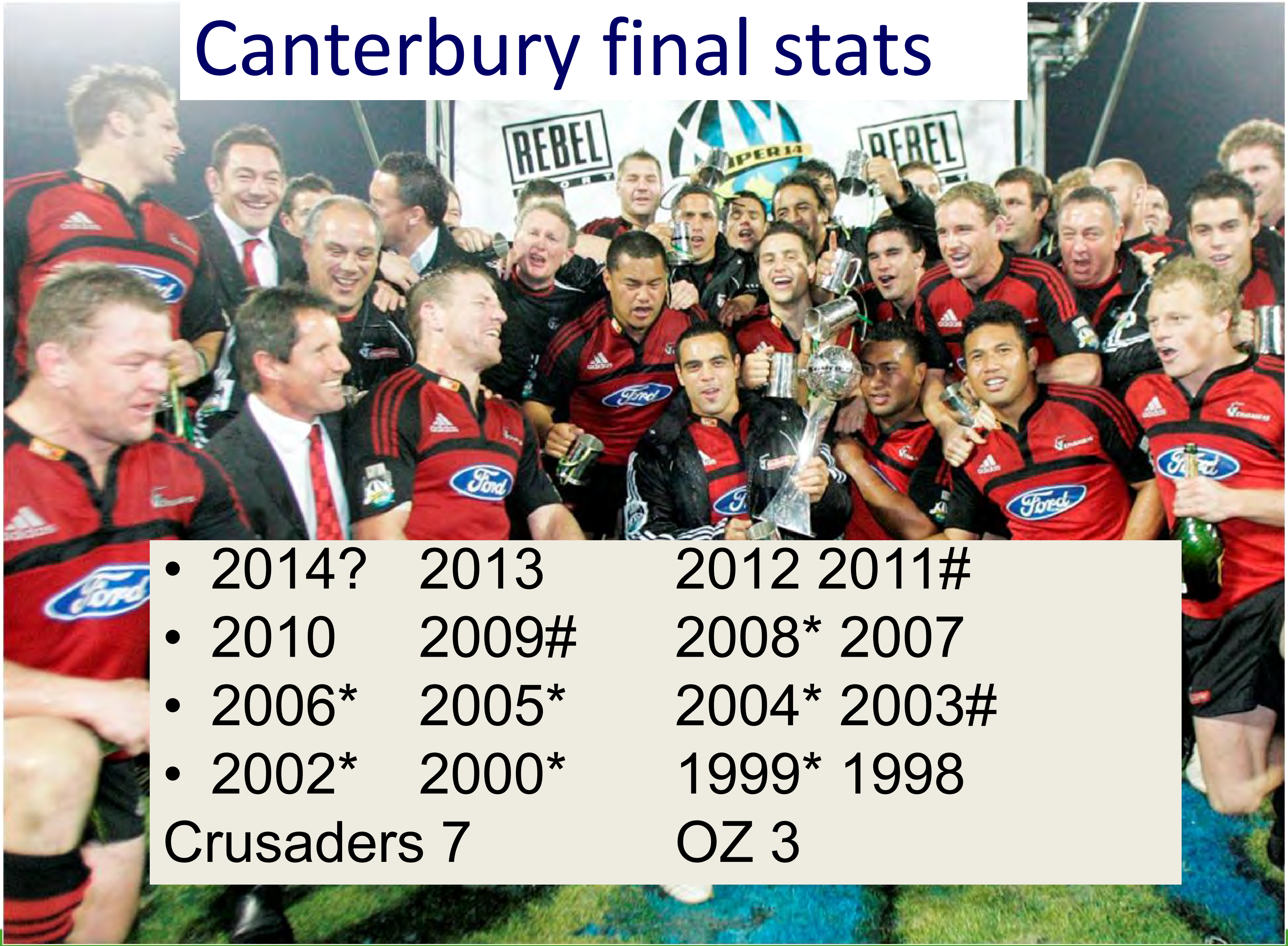
High values seed crops

10,000 ha clover seed for export

Herbage grass 1.5 - 2.5 t seed/ha

Wine production in Nth Canterbury

Canterbury final stats



- 2014? 2013 2012 2011#
- 2010 2009# 2008* 2007
- 2006* 2005* 2004* 2003#
- 2002* 2000* 1999* 1998

Crusaders 7 OZ 3

Policy & management questions

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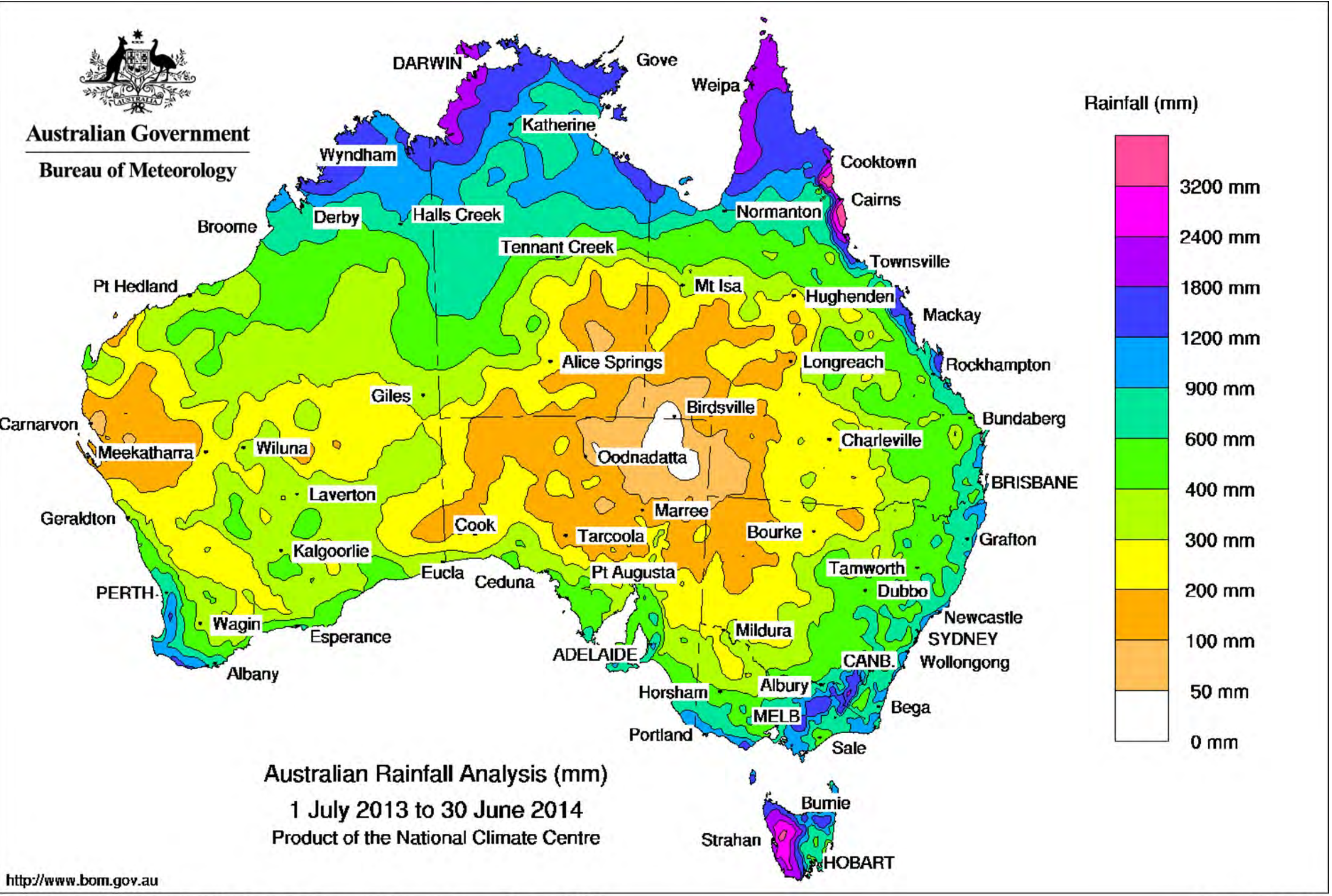
- What types of land uses, and

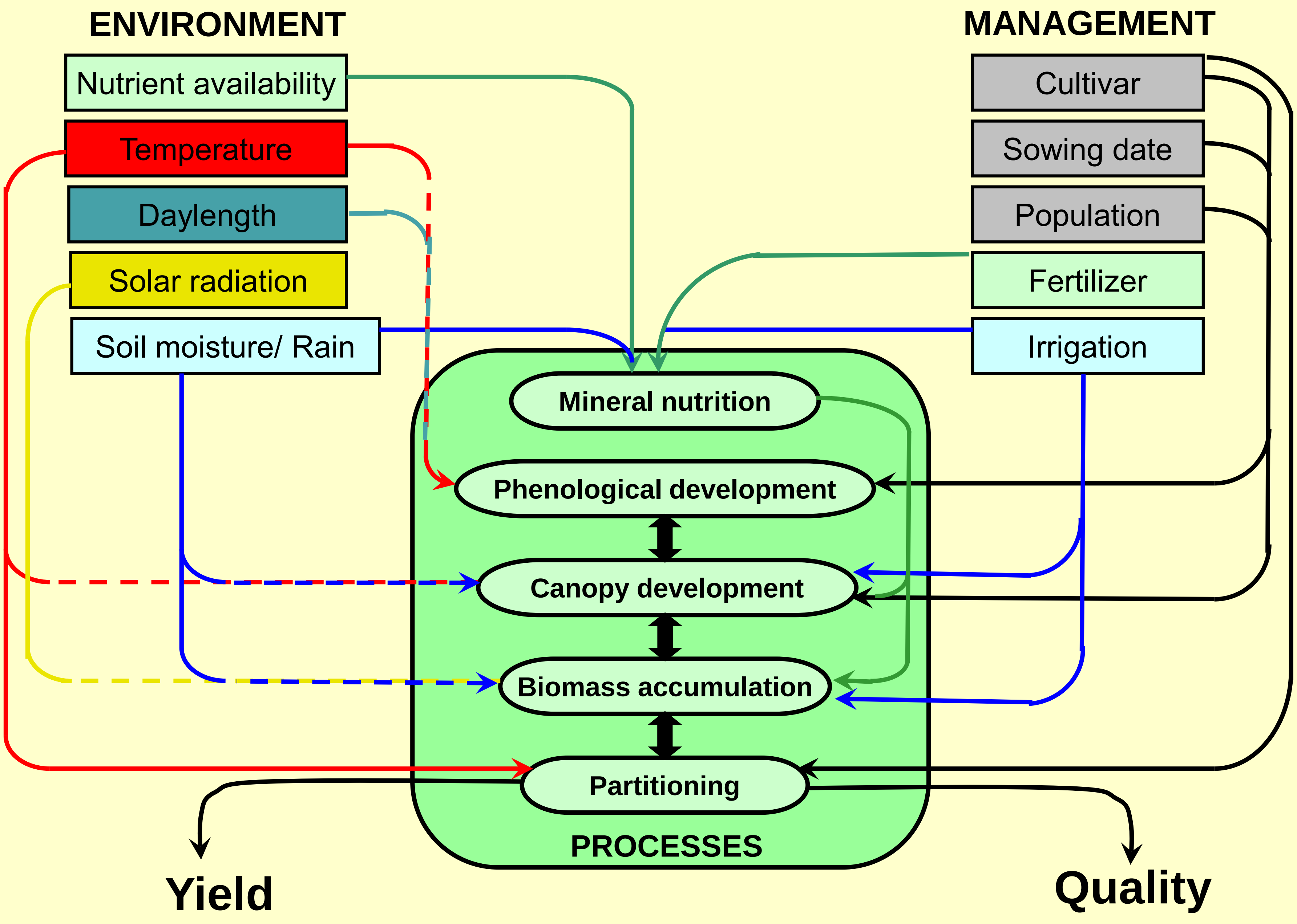
- How intensive can they be without exceeding a groundwater system's limits? – nitrogen mgmt

- How might land be managed to maximize profitability and remain within the N limits?

  i.e. How many dairy farms, potato farms, onion paddocks, market gardens, sheep paddocks… should be allowed on a "catchment"?



© Commonwealth of Australia 2014, Australian Bureau of Meteorology ID code: AWAP Issued: 03/07/2014



Relationship between environment and management factors and the physiological processes that regulate crop yield and quality. (Source: Hay & Porter 2006).

Growth vs Development

Growth: an irreversible increase in DM

- function of light interception and
- photosynthesis and then
- assimilate partitioning

Development: irreversible change in the state of an organism

- fixed pattern and reversion is rare

e.g. silking,
pod initiation,
dough development

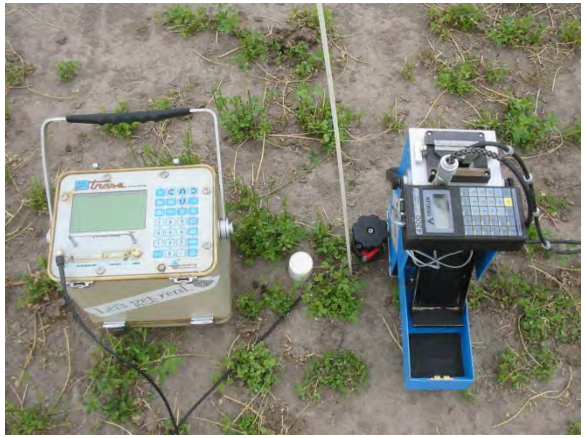
Measurements

Light environment

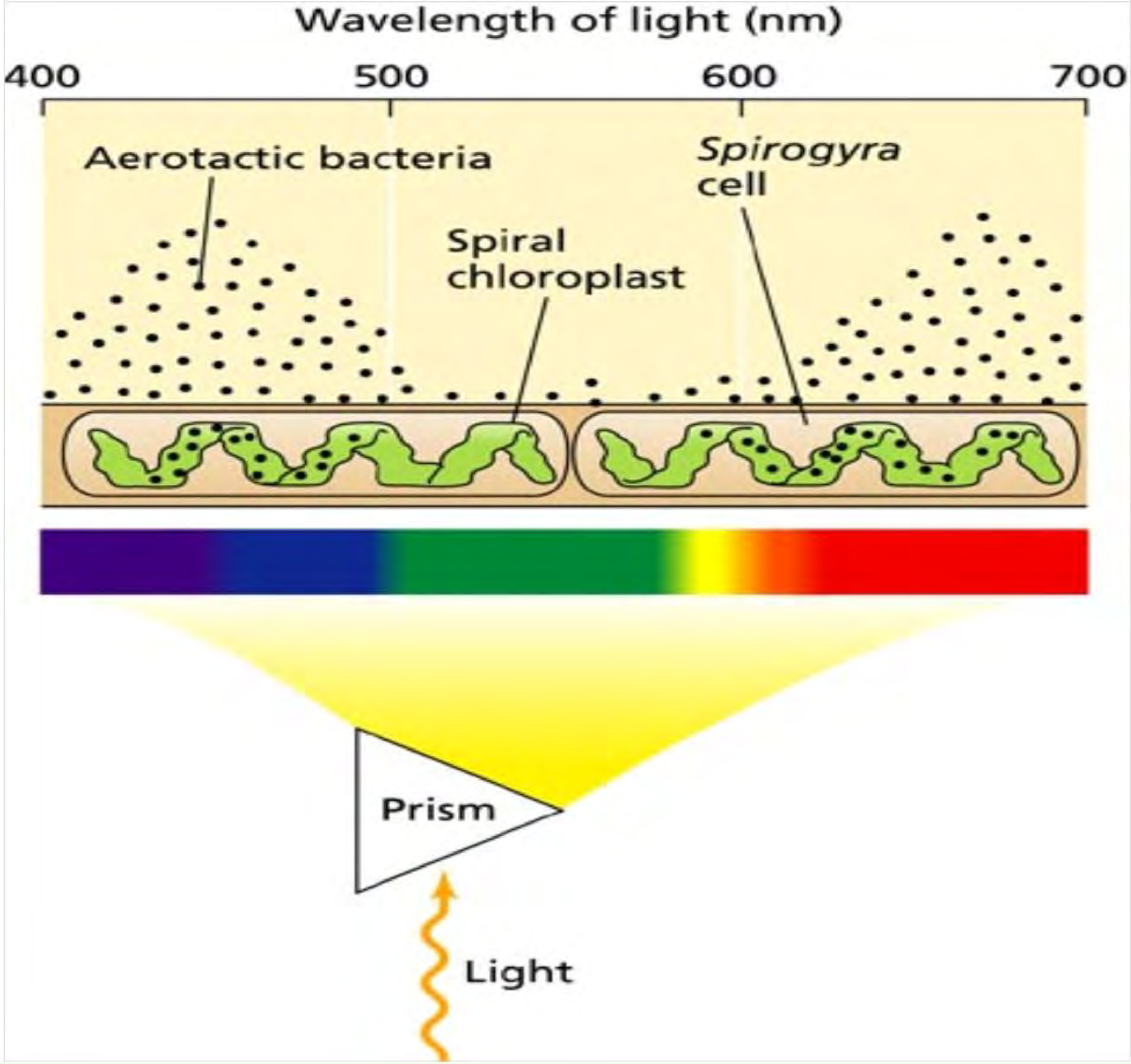
<u>Chemical Analysis:</u>
-N (shoots and roots)
-Starch in roots
-Soluble sugars in roots

<u>Temperature</u>
- Air and soil

Soil moisture



Photosynthesis



Taiz & Zeiger, 2010

The canopy:
the energy capture device

Crop Growth and Yield

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1) **C = E*Q**

C = daily rate of DM prod.

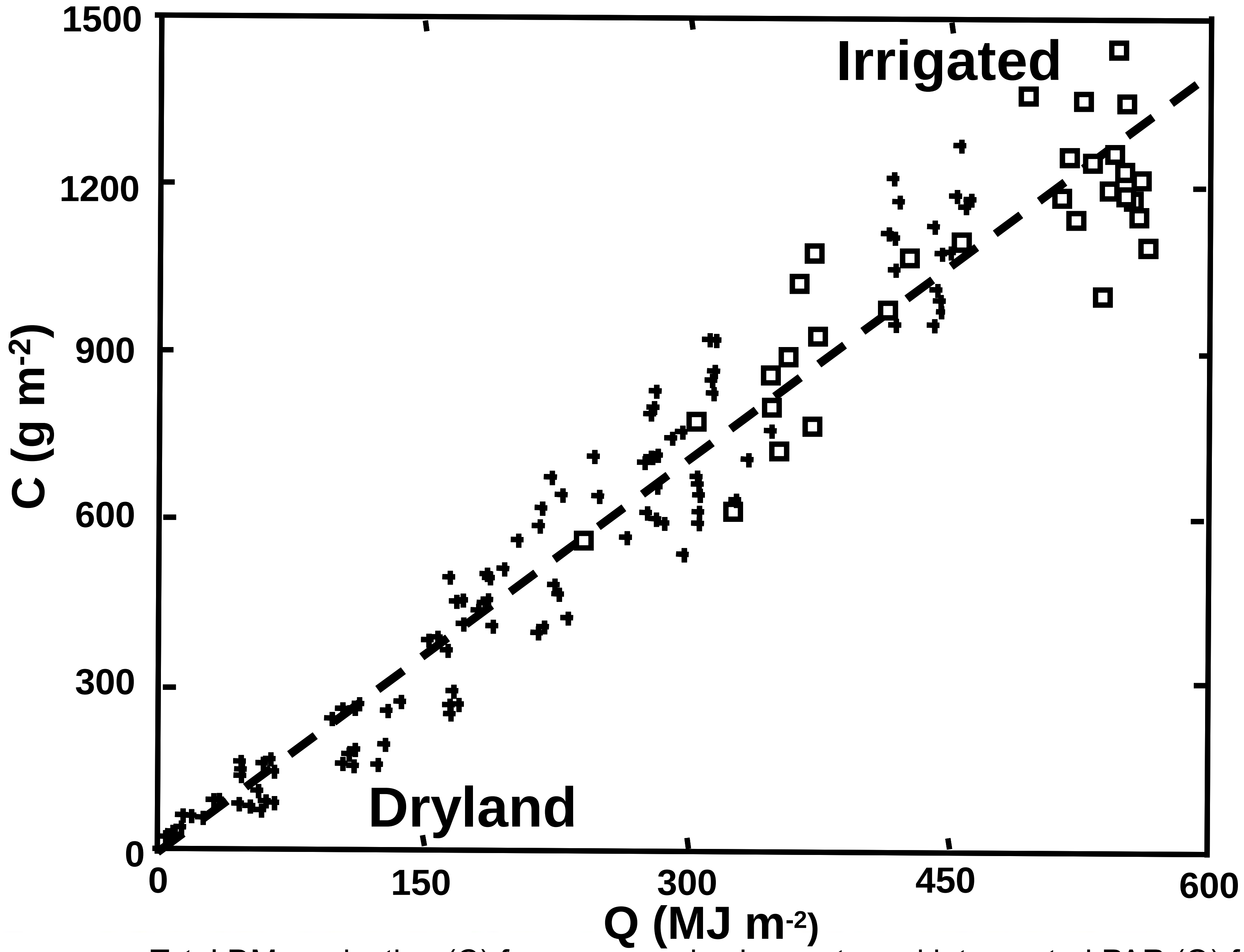
E = radiation use efficiency

Q = PAR intercepted

2) **Y = HI*C*dt**

Y = seed yield/unit area

HI = harvest index



Total DM production (C) from successive harvests and intercepted PAR (Q) for field peas in 5 experiments in 4 seasons with different cultivars, sowing times and irrigation treatments. The form of the regression is: 2.36±0.03 g DM/MJ PAR (R^2=0.97). Source: Wilson 1987

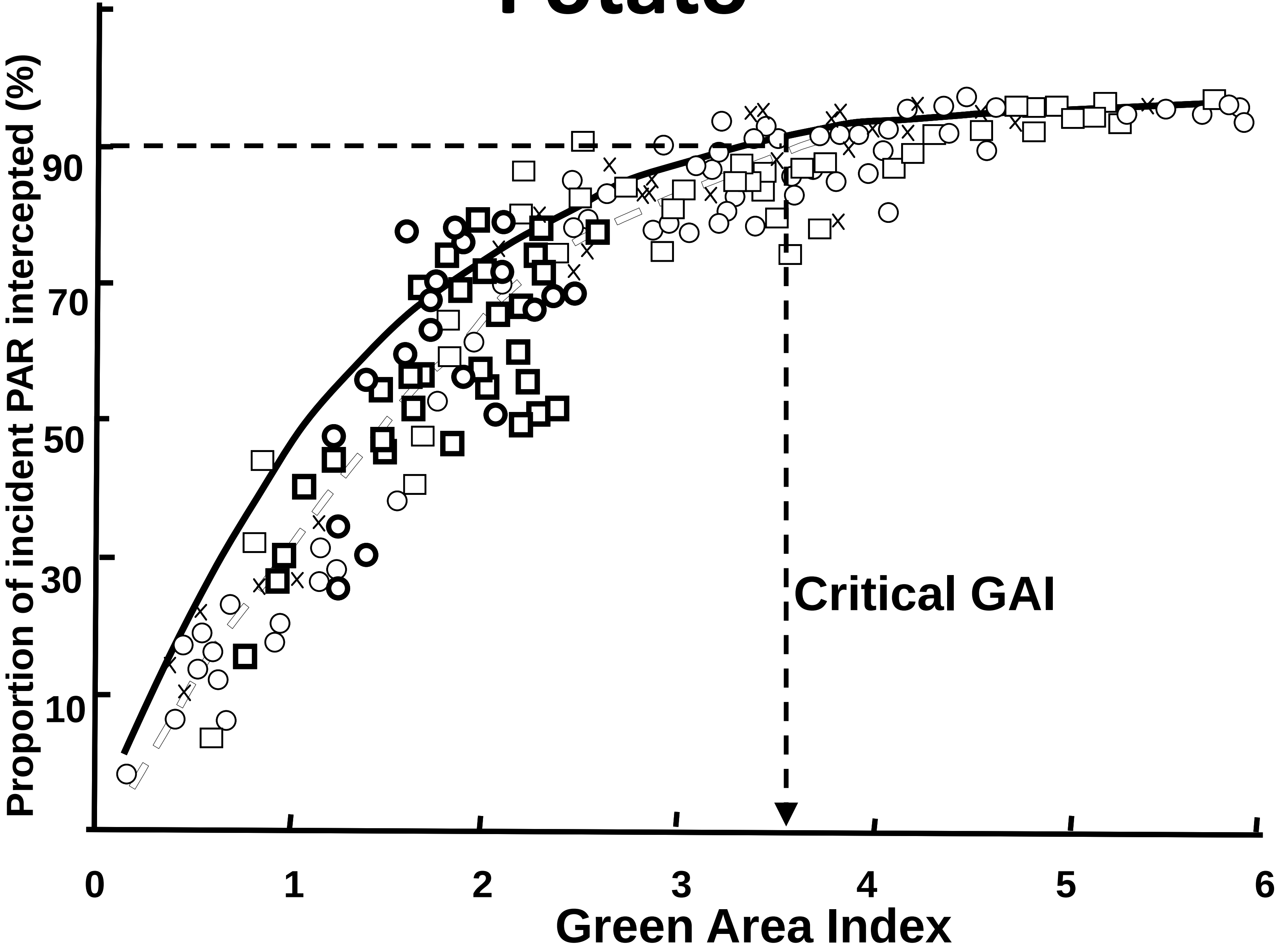
Light

- photosynthesis to produce CHO's for growth.

- Photosynthetically active radiation (PAR) is in the visible range (400-700nm).

- Conversion of PAR to DM
~2.5 g DM /MJ/m^2 for C3 plants
~3.8 g DM /MJ/m^2 for C4 plants

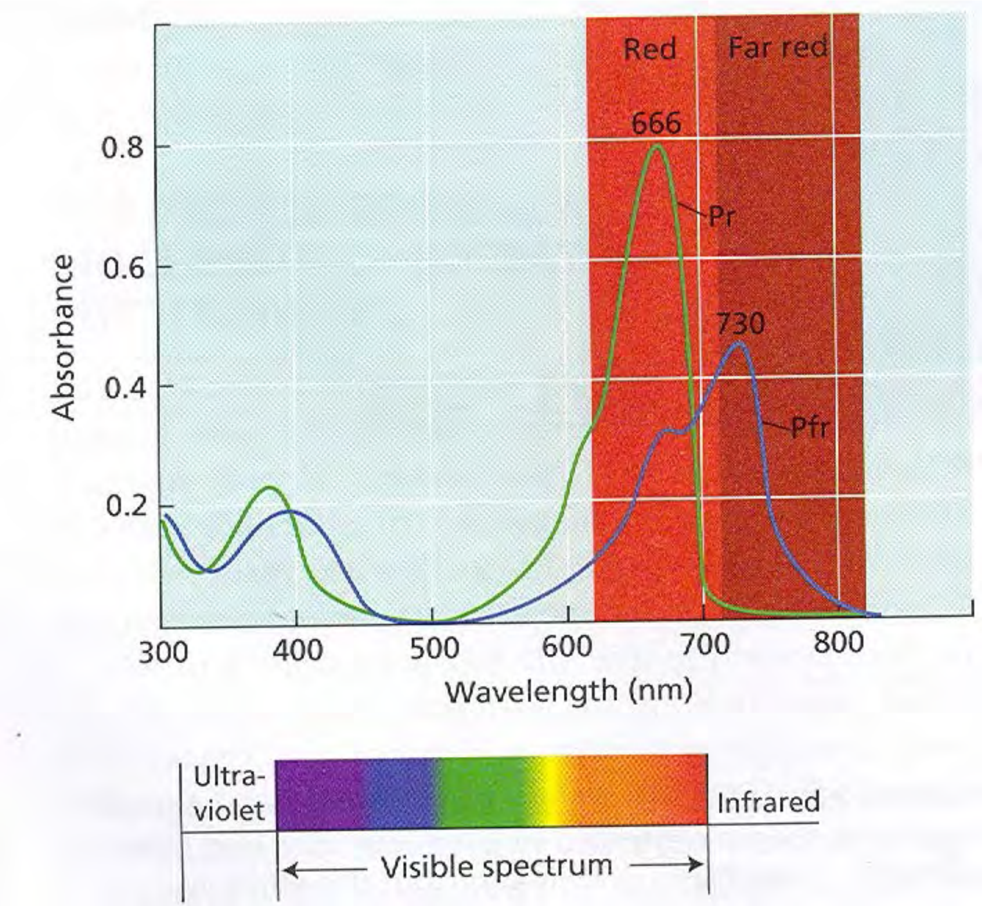
Potato



(Source: Khurana & McLaren 1982)

Light

- **Complex & dynamic sign**
- **Quantity of light**
  - photons falling /area/time
- **Quality of light**
  - plant responses



Plant development

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A) Vegetative

- Emergence and - temperature
- Leaf appearance rates (phyllochron)- temperature

B) Reproductive

- Time of flowering (anthesis), Temperature and photoperiod
- Duration of grain fill -temperature

Driven by temperature modified by photoperiod and vernalization

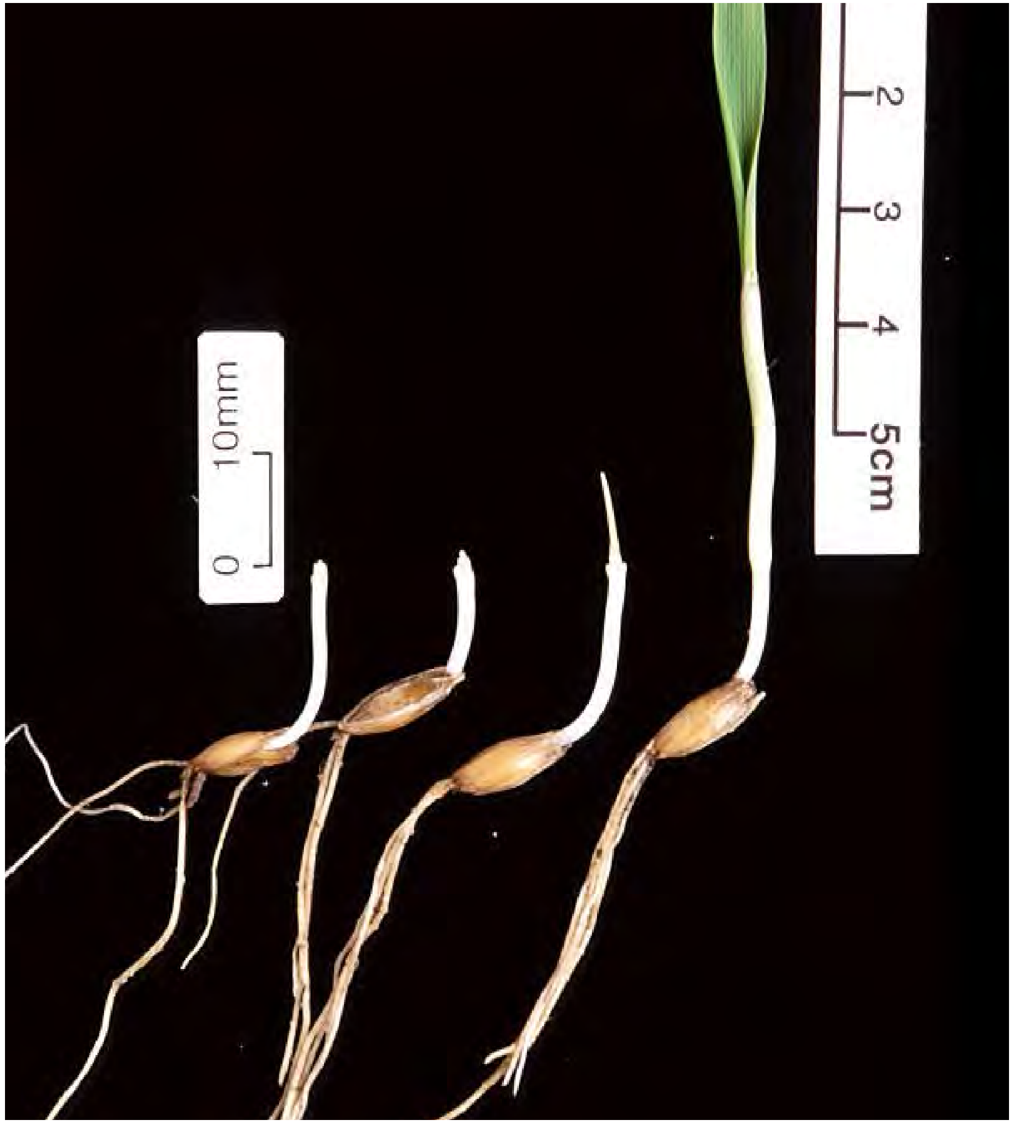
Temperature

- Tt = Thermal time (°Cd)

$$= \frac{Tmax + Tmin}{2} - T_b$$

- Growing degree days (GDD)
- Heat units (HU)

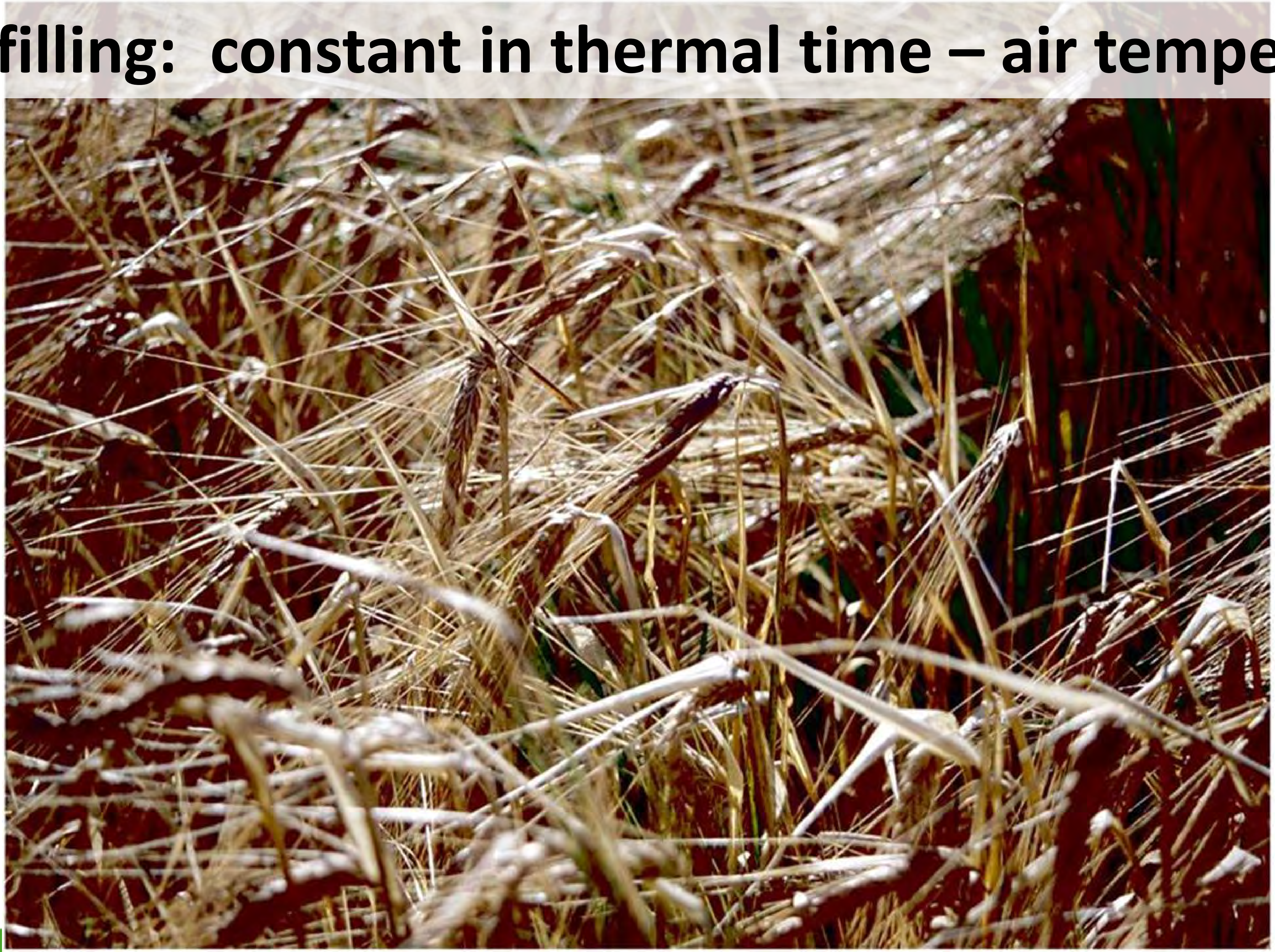
Sowing to emergence



Thermal time
- **soil temperature**

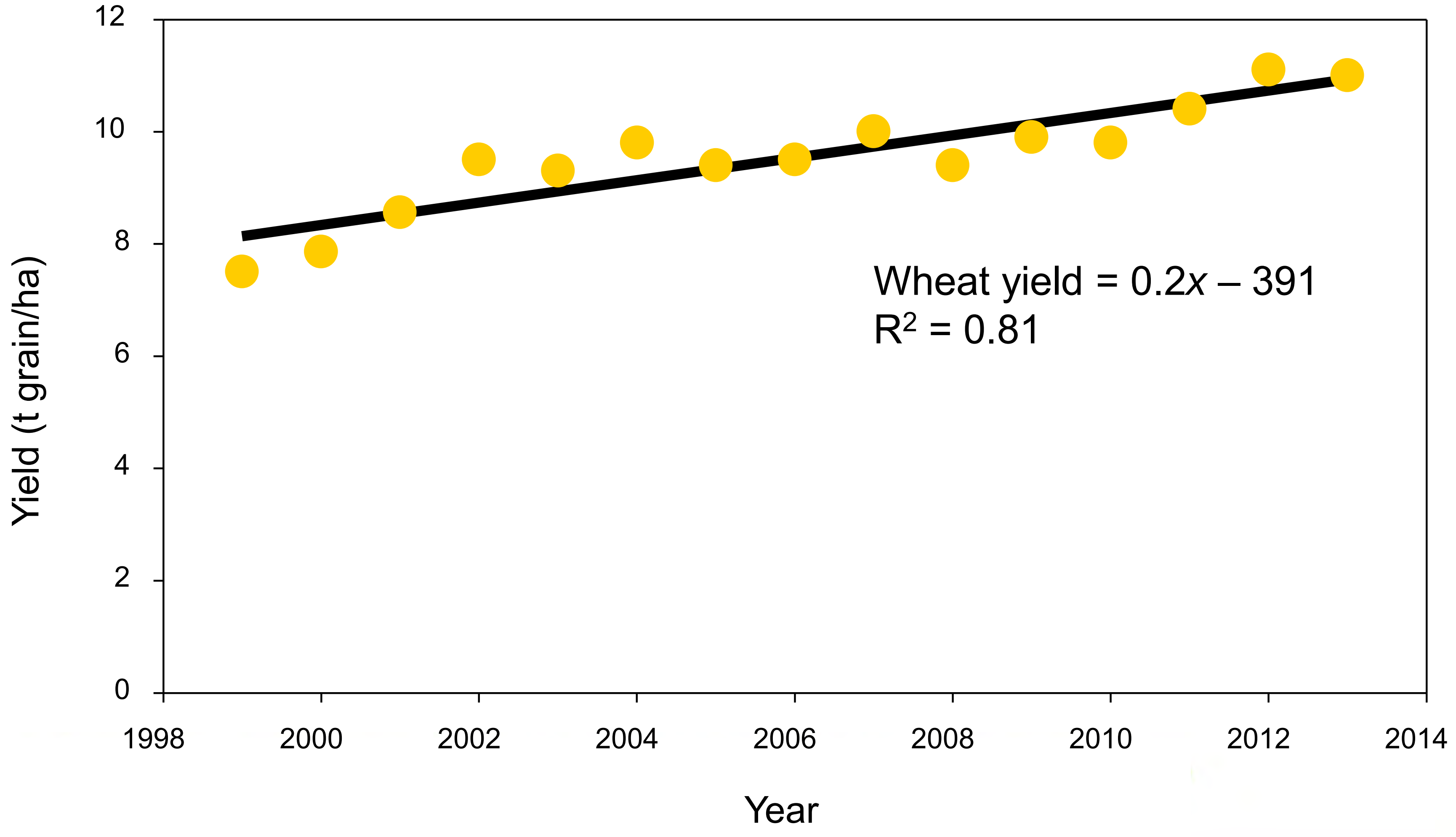
~ 125-150 °Cd

Grain-filling: constant in thermal time – air temperature

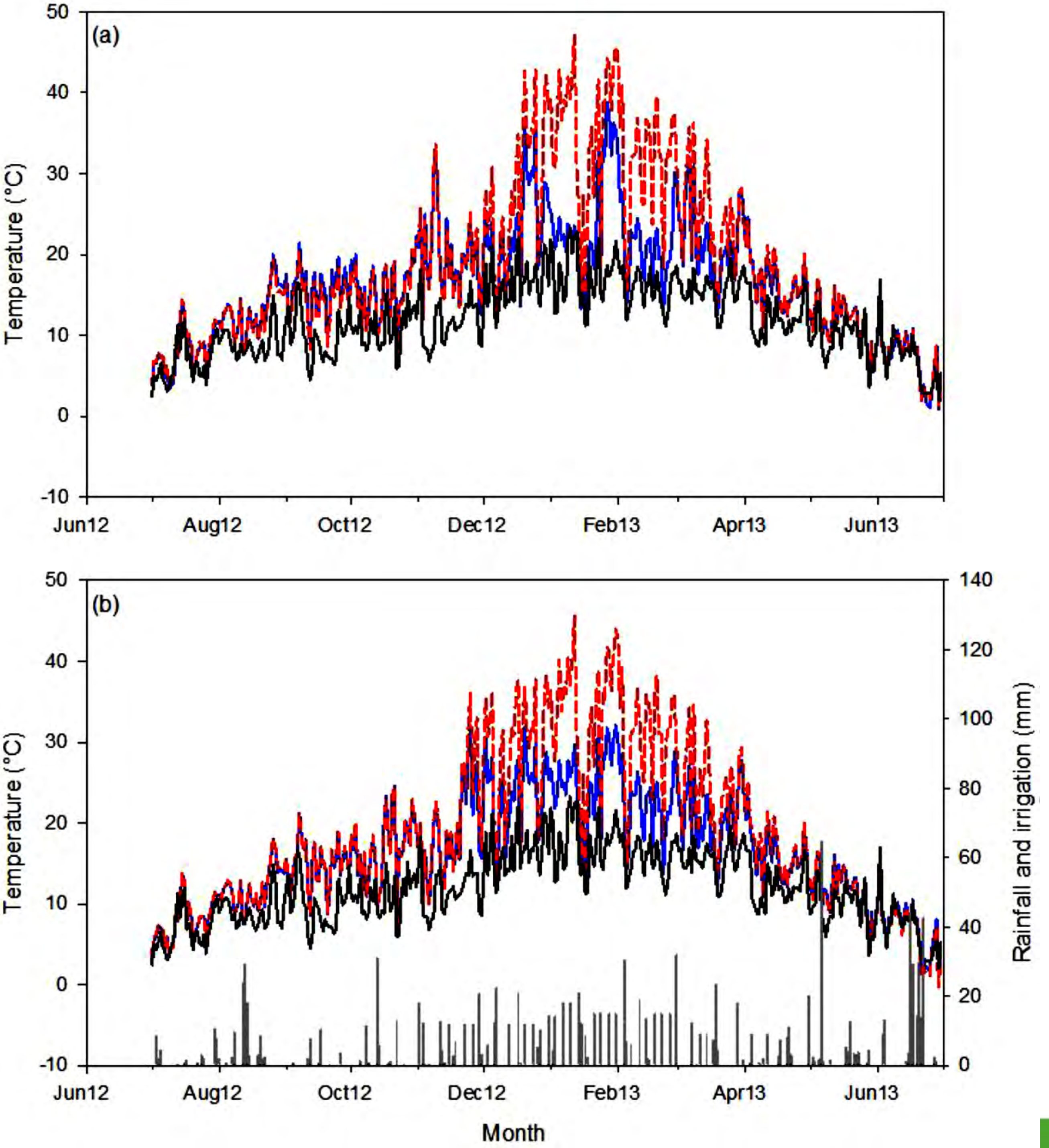


Wheat 15 t/ha; 40,000 ha
Barley 13 t/ha; 40,000 ha

Wheat grain yields in Canterbury



Source: Cereal performance trials
FAR, Canterbury



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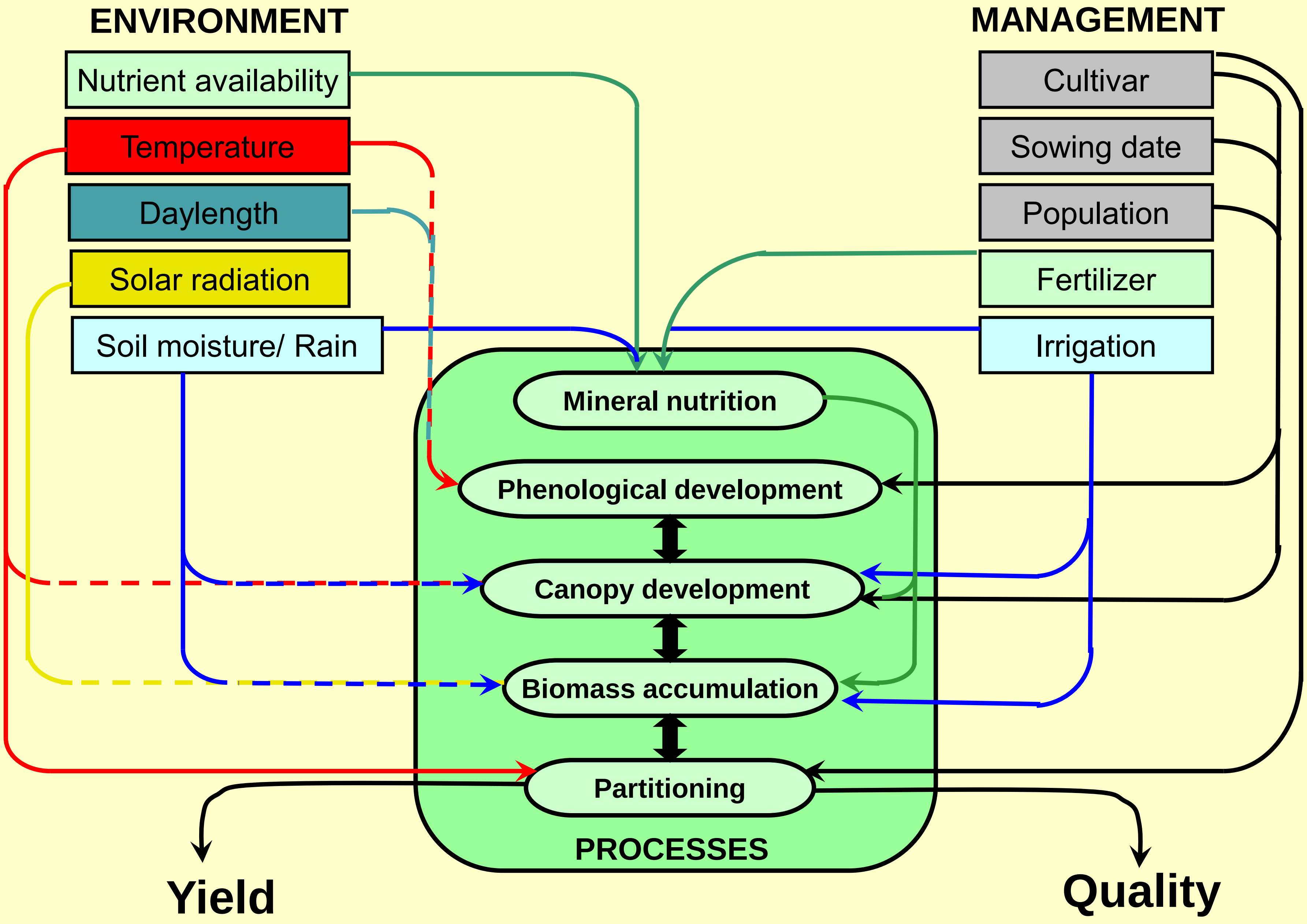
Mean daily canopy temperatures (°C) of (a) lucerne and (b) perennial ryegrass fully irrigated (■) and unirrigated (■)pastures against air temperature (■) and rainfall and irrigation (mm, ■) from1/07/2012 to 30/06/2013

Murray-Cawte, 2013



Relationship between environment and management factors and the physiological processes that regulate crop yield and quality. (Source: Hay & Porter 2006).

Olsen P<6

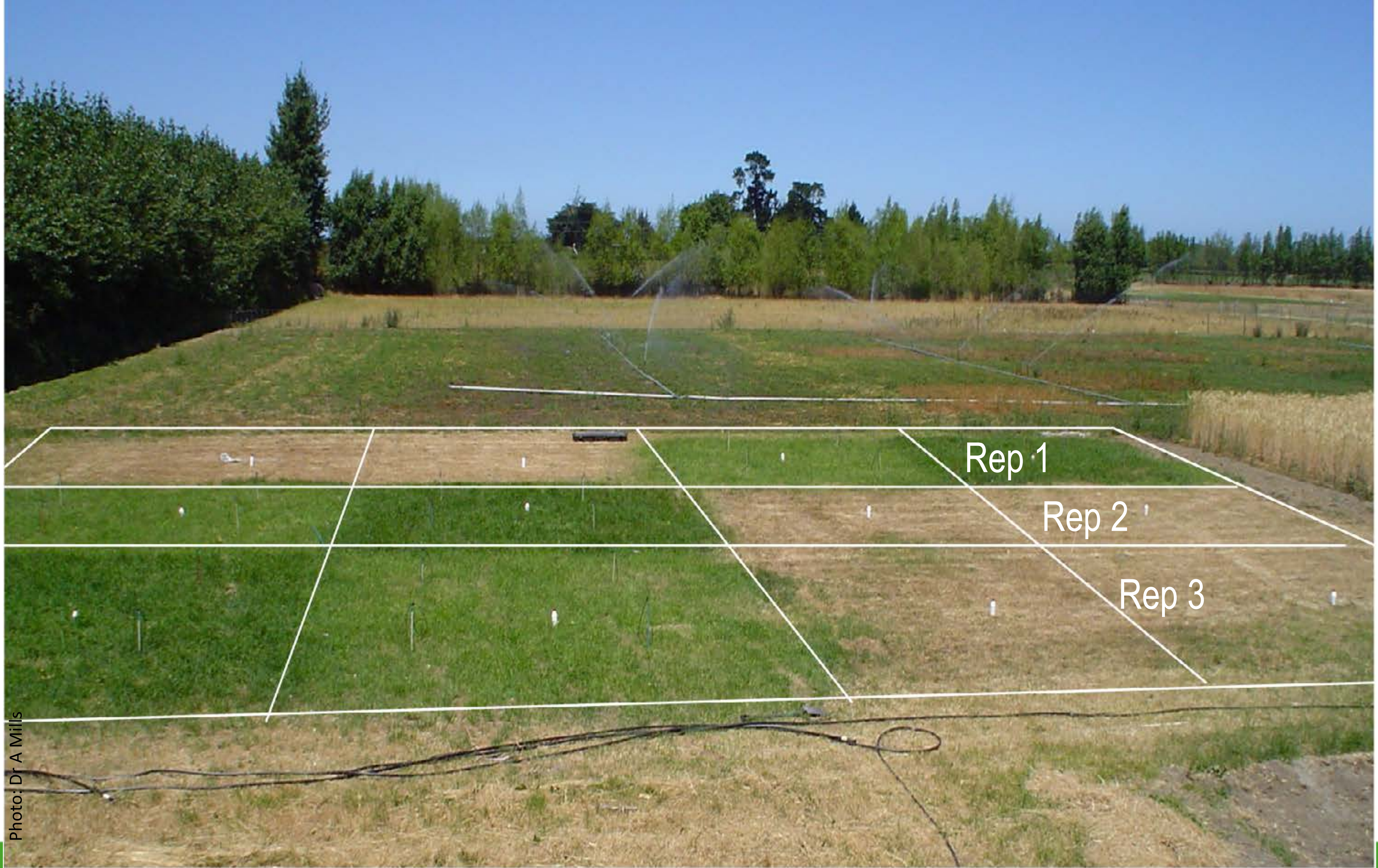
Photo: Dr A.L. Fletcher

Olsen P>20

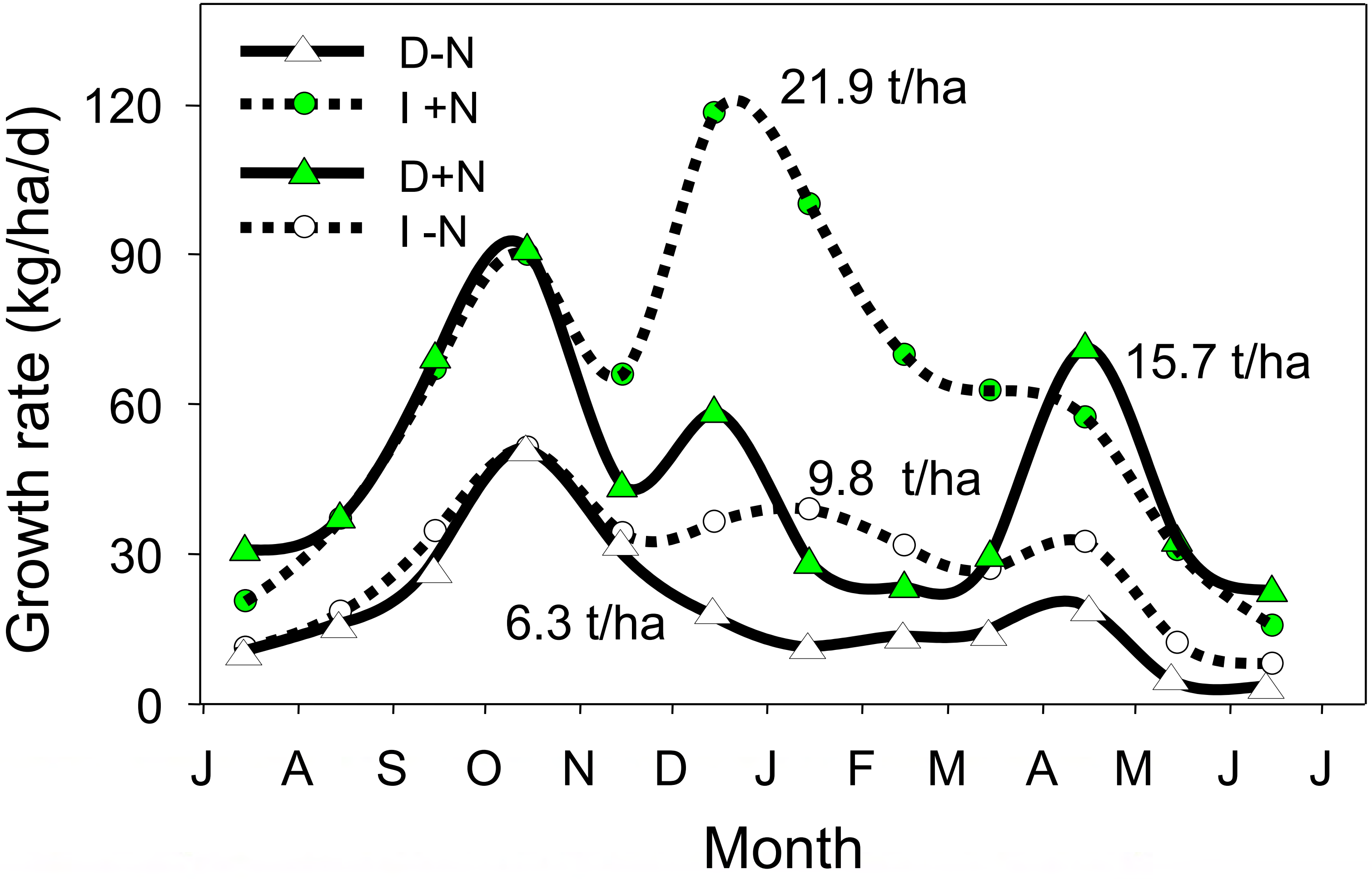
Drilling seed with fertiliser

Direct drilling = seed + fertiliser

Experiment site



Growth rates (2 year means)



Mills *et al*. 2006


Photo: Dr KM Pollock

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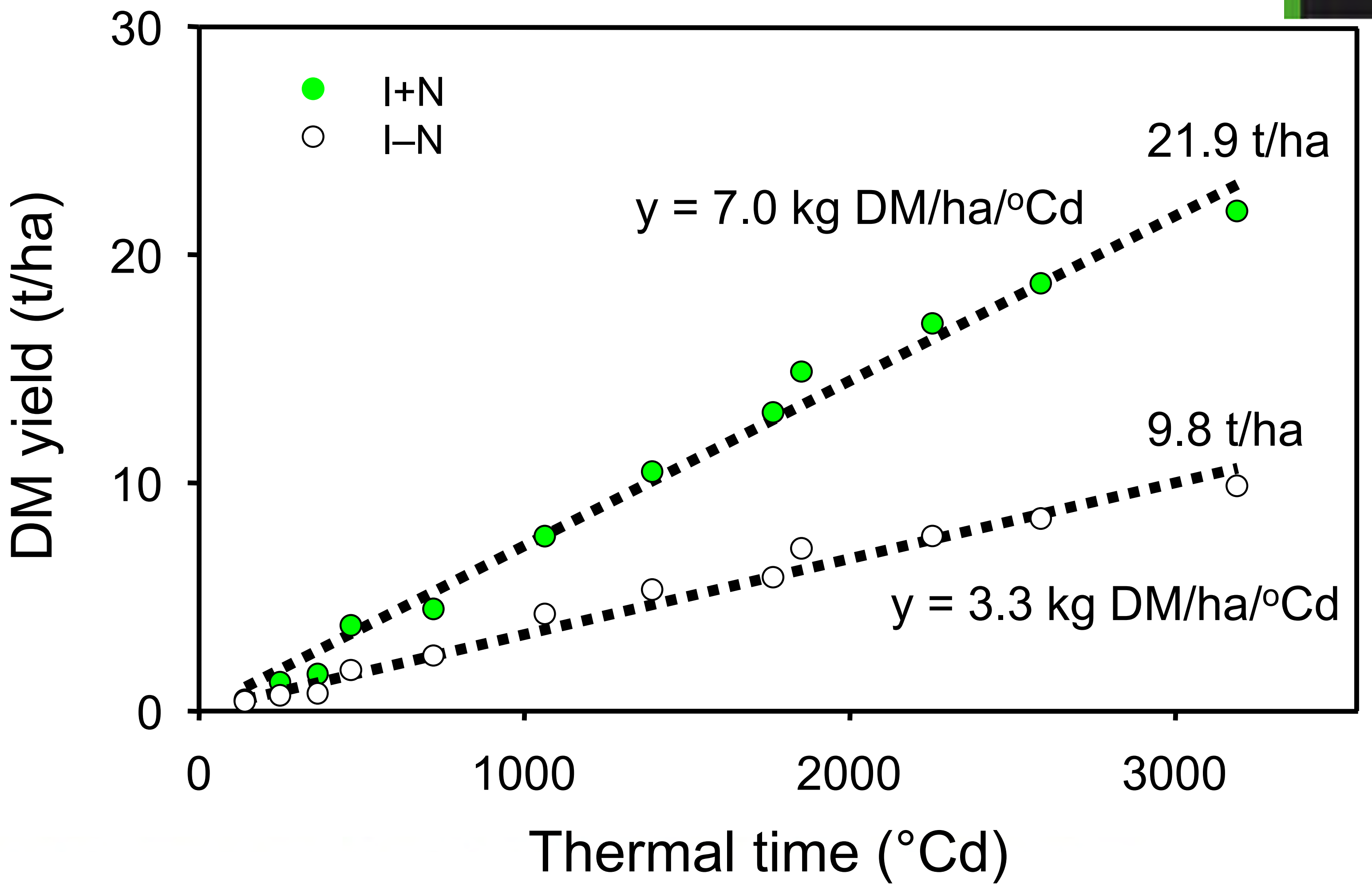
Winter
⇒ temperature response

DM yield response to thermal time (T_b = 3°C)



(Source: Mills *et al*. 2006)

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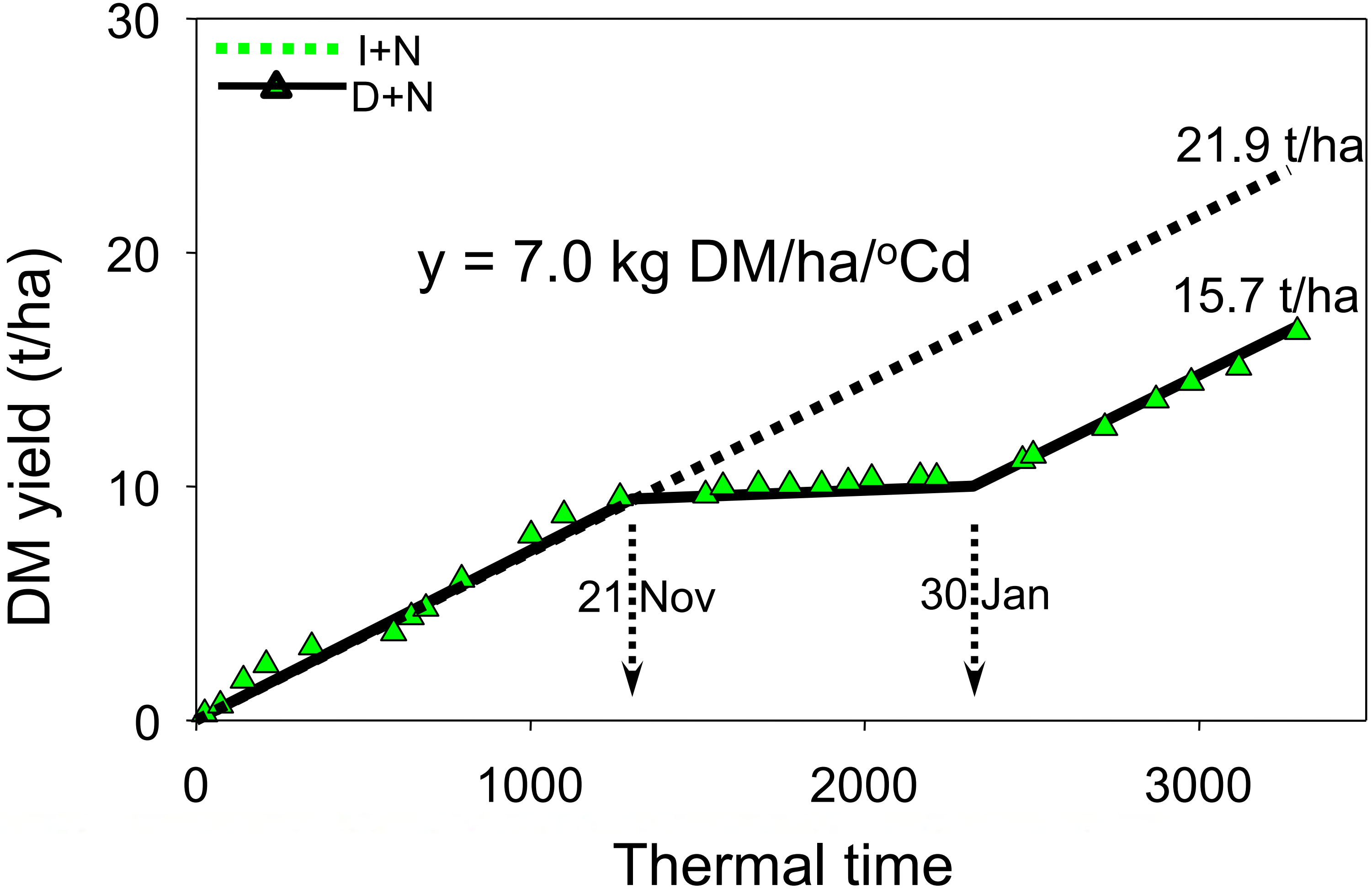
Summer

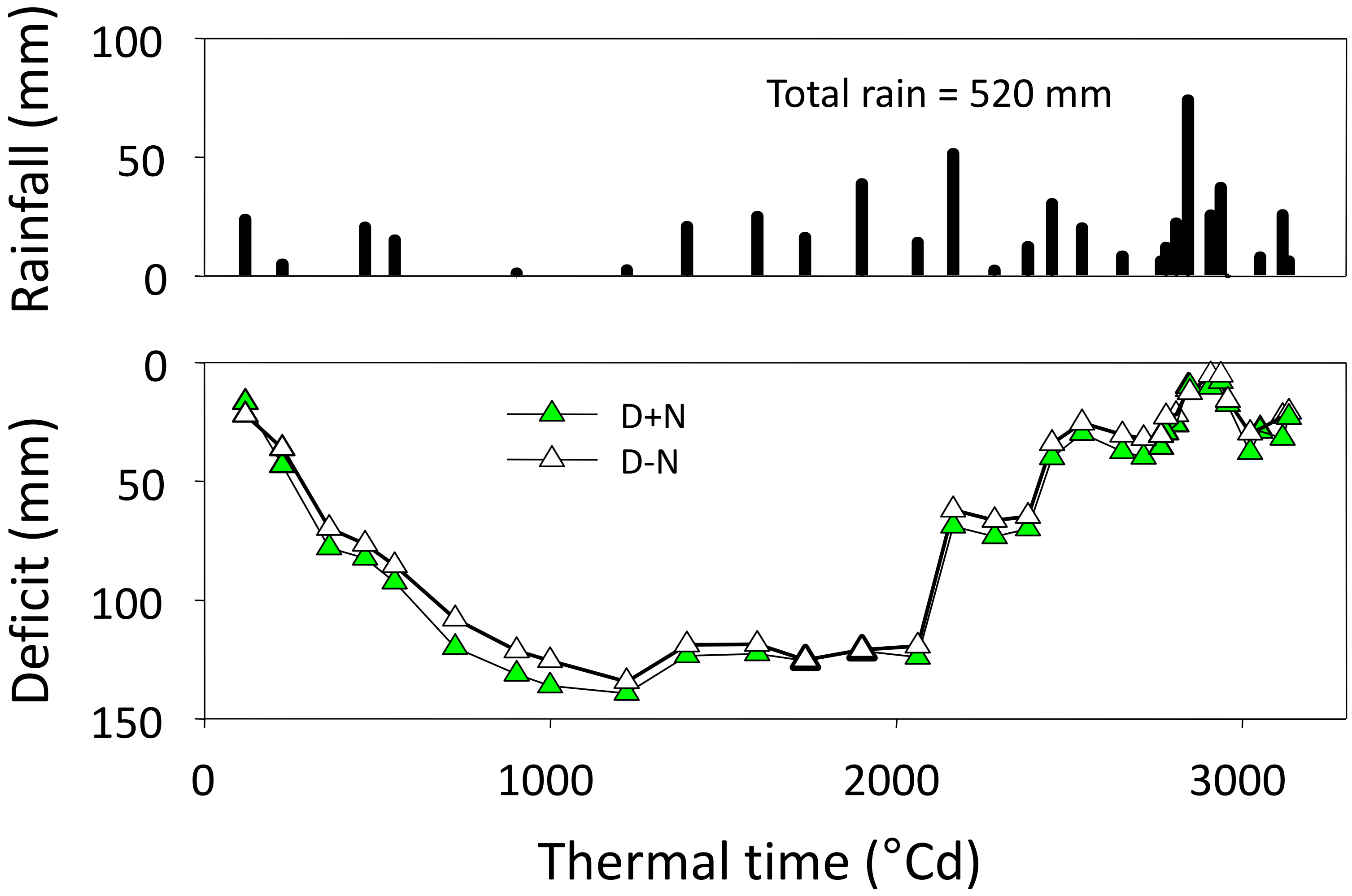
⇒ moisture response

Water stress effect on yield

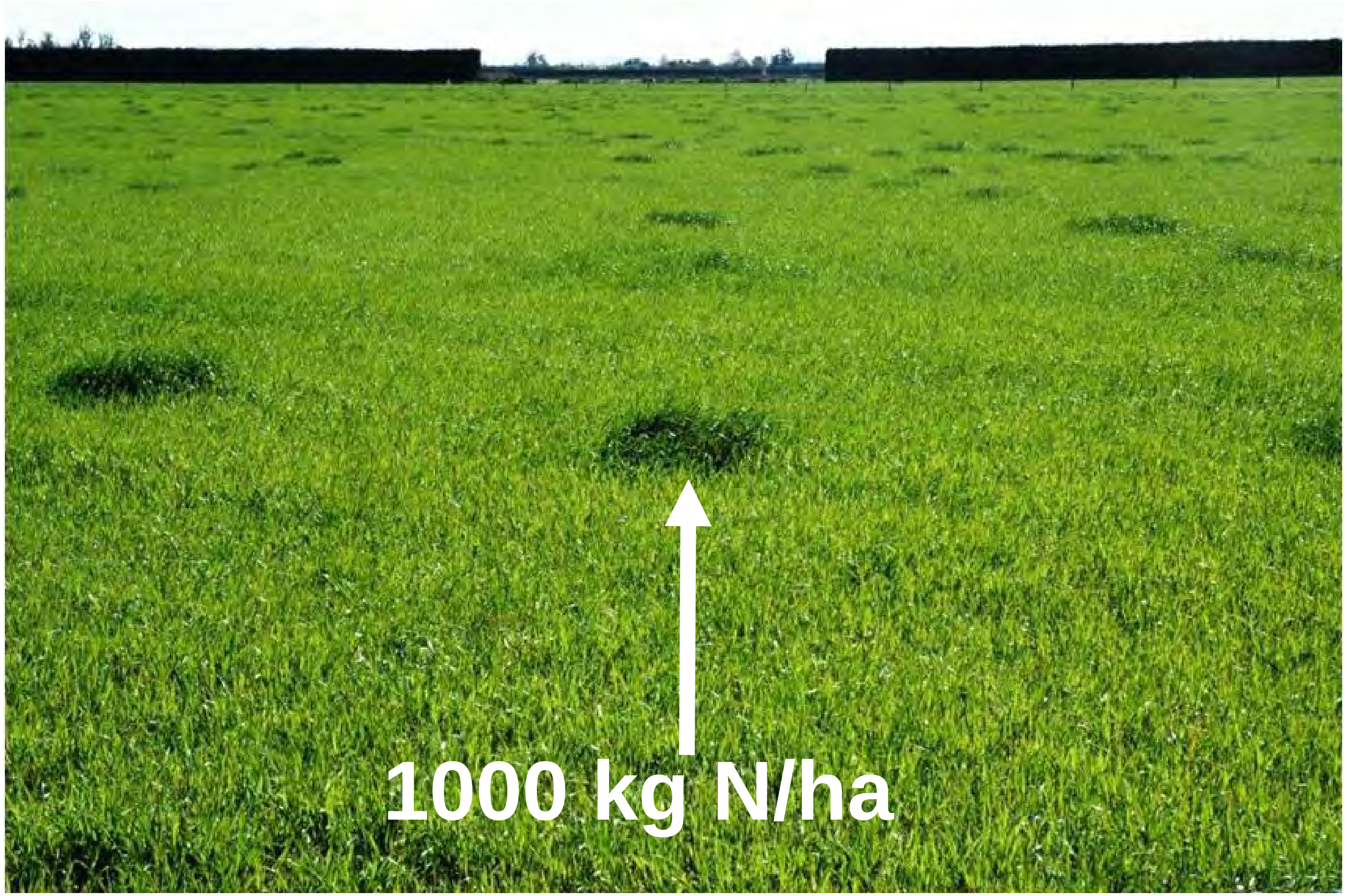


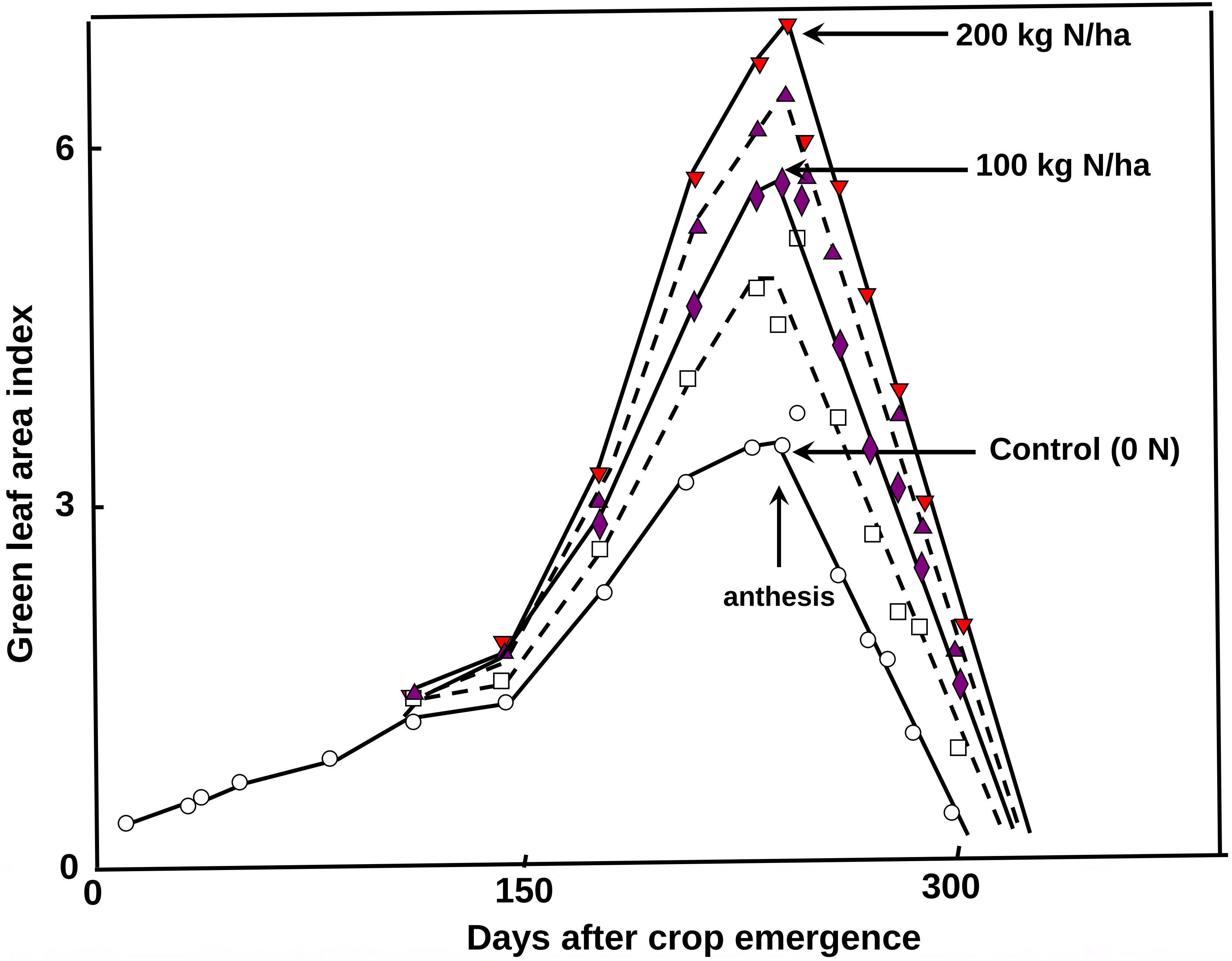
(Source: Mills *et al*. 2006)

Soil moisture deficit 2003/04



Nitrogen deficient pasture – inefficient user of water





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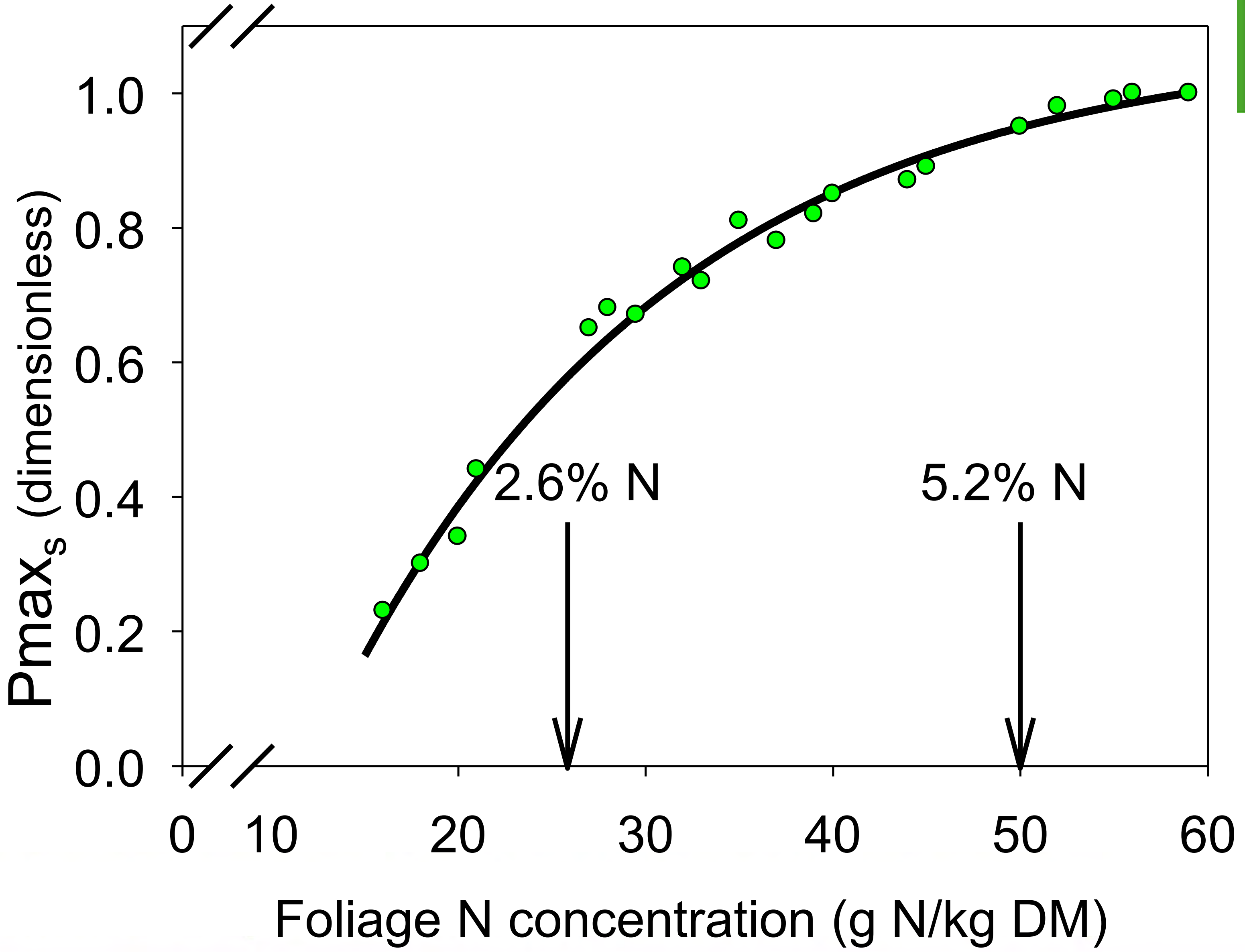
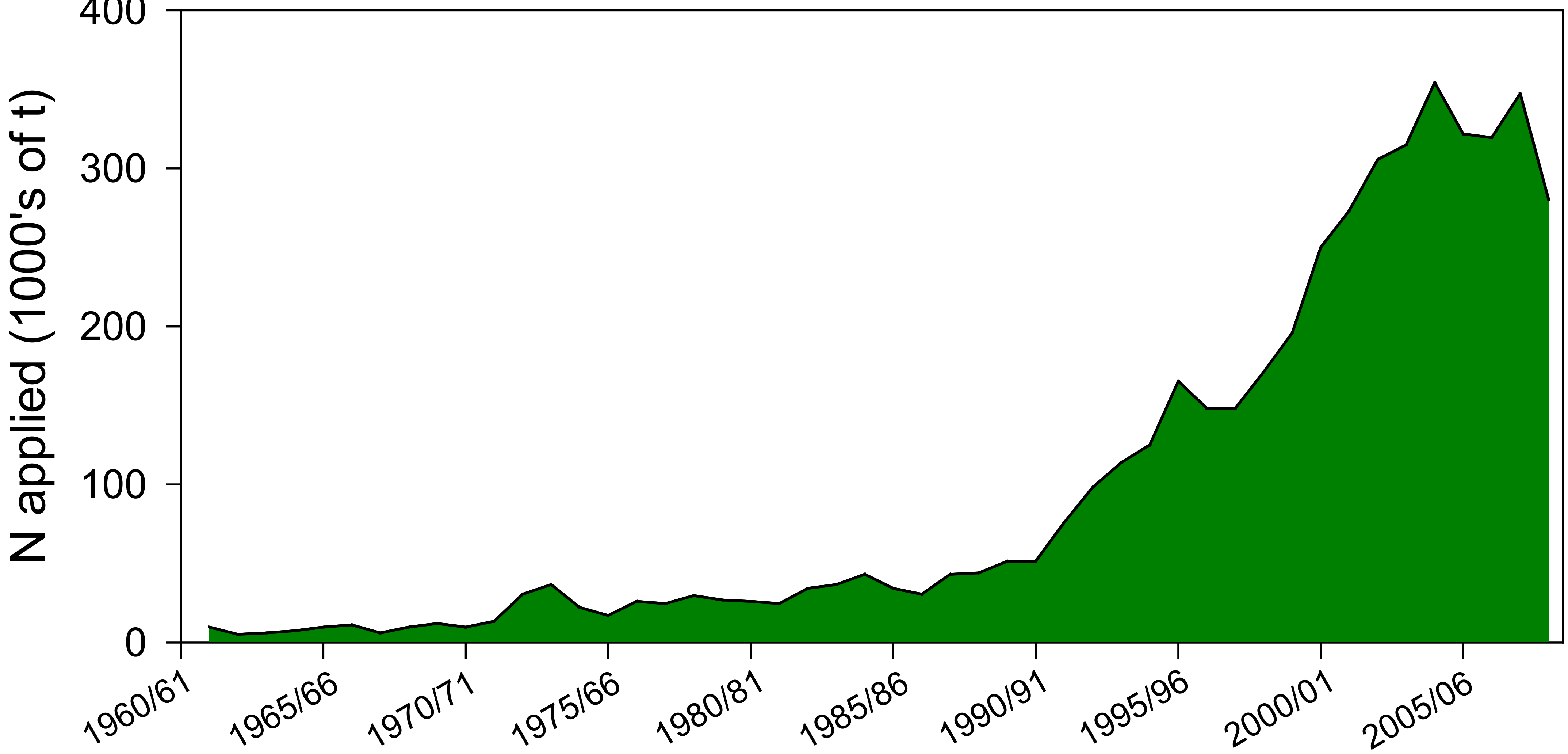
(Source: Green 1987)

Plant vs animal requirements



(Source: Peri *et al.* 2002)

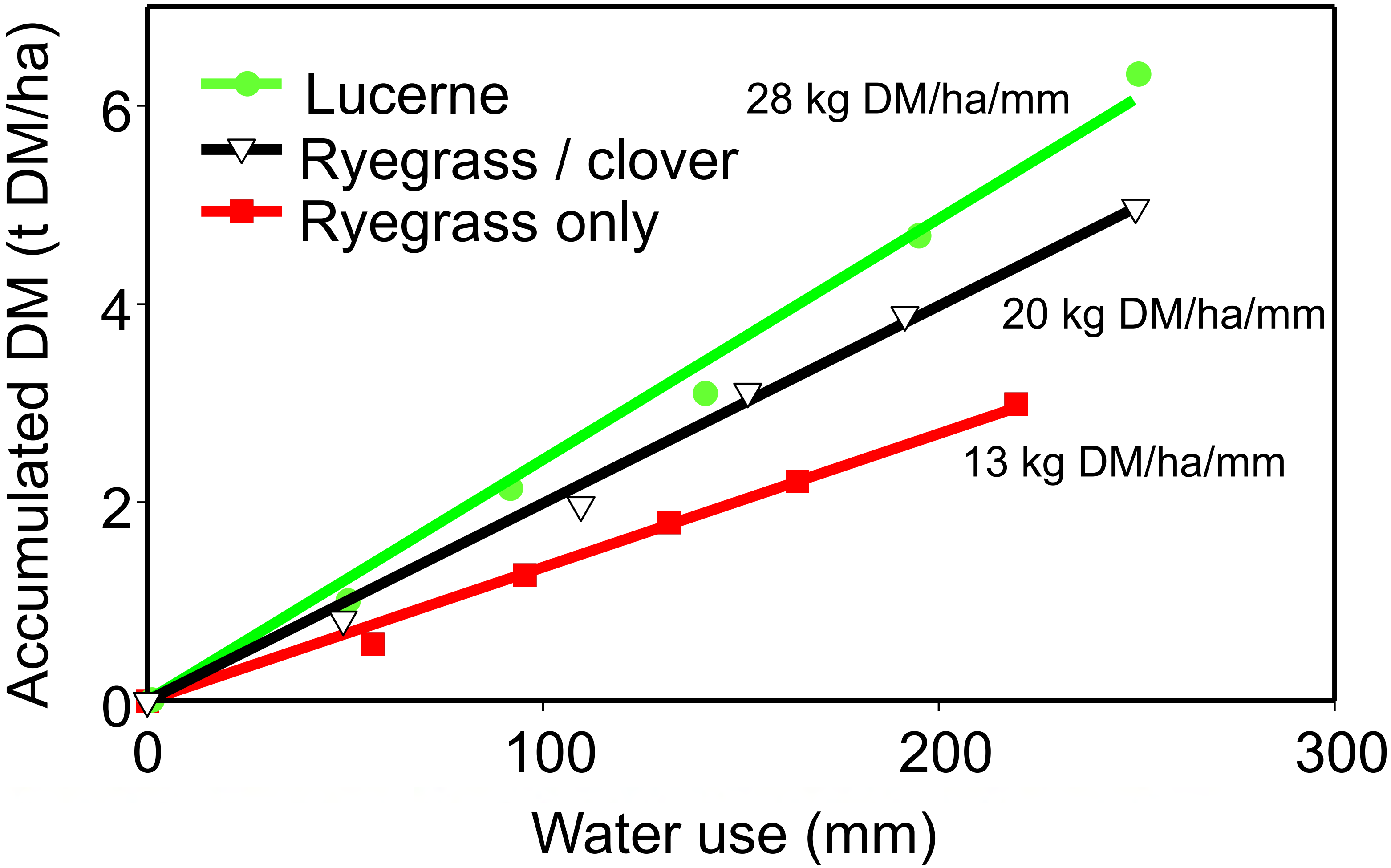
Nitrogen fertiliser use



Source: New Zealand Fertiliser Manufacturers' Research Association

How can we increase WUE on-farm?

Spring WUE: legume = (nitrogen)

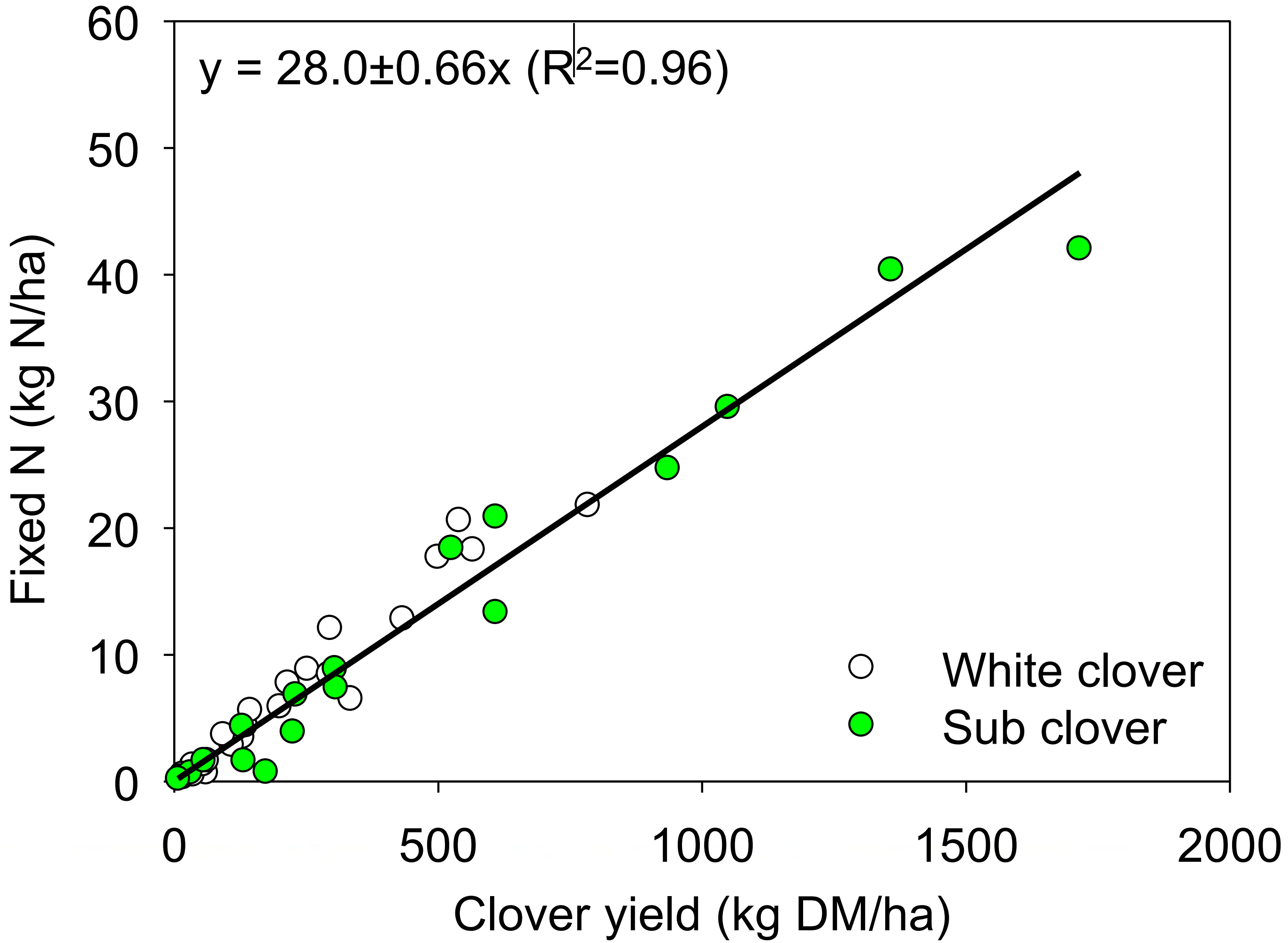


(Source: Moot *et al.* 2008)

‘Rosabrook’ subterranean clover

Photo: Dr A.D. Black

Biological N fixation

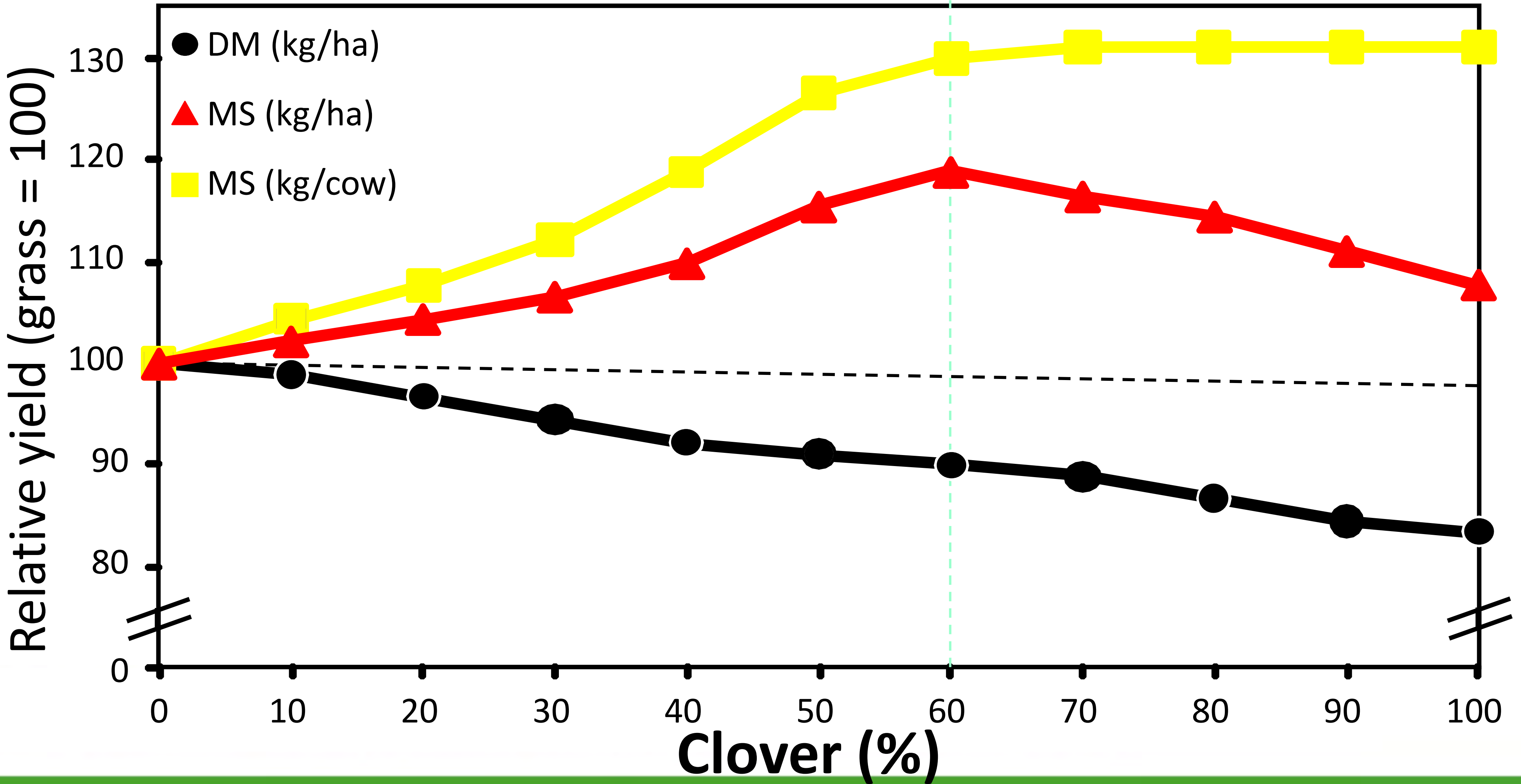


(Source: Lucas *et al*. 2010)


Photo: Dr DJ Moot

Sheep prefer 70% legume, 30% grass

Clover content & milksolids production



Cosgrove, 2005 - SIDE

Sheep prefer 70% legume, 30% grass


Russell lupin grazing trial at Sawdon Station
High aluminium soils
Photo: Dr AD Balck

Conclusions

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- Light interception drives dry matter production
- Temperature (air and soil) affect crop development
- NTW water affect leaf area expansion and Ps.
- Spring gives highest WUE
- Agronomists role is to balance nitrogen and water
- WHICH LEGUME? – When to use urea?
- Optimize production with minimal footprint

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Dryland pastures blog: http://www.lincoln.ac.nz/conversation/drylandpastures/

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